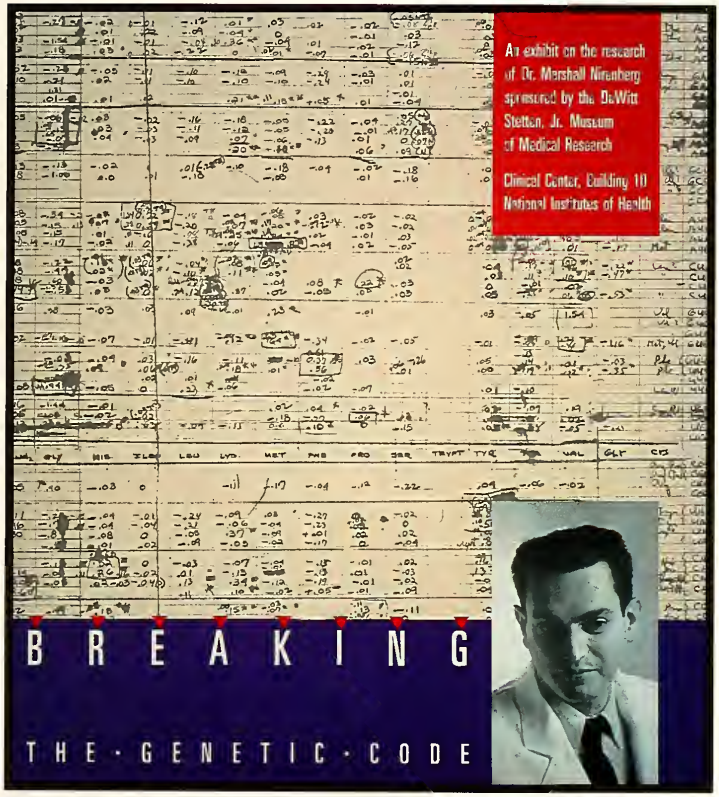
An exhibit on the research of Dr. Marshall Nirenberg sponsored by the DeWitt Stetten, Jr. Museum of Medical Research
Clinical Center, Building 10
National Institutes of Health
BREAKING
THE · GENETIC · CODE

Telling the Stories of Biomedical Ethics

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Telling the Stories of Biomedical Ethics

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All subscription communications should be addressed to:
Department of Medical Humanities
Southern Illinois University
School of Medicine
P.O. Box 19230
Springfield, Illinois 62794-9230
Phone (217)782-4261

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The Nuremberg Code

1. The voluntary consent of the human subject is absolutely essential.

2. The experiment should be such as to yield fruitful results for the good of society, unprocurable by other methods and means of study, and not random and unnecessary in nature.

3. The experiment should be so designed and based on the results of animal experimentation and a knowledge of the natural history of the disease or other problem under study that the anticipated results [will] justify the performance of the experiment.

4. The experiment should be so conducted as to avoid all unnecessary physical and mental suffering and injury.

5. No experiment should be conducted where there is an a priori reason to believe that death or disabling injury will occur; except, perhaps, in those experiments where the experimental physicians also serve as subjects.

6. The degree of risk to be taken should never exceed that determined by the humanitarian importance of the problem to be solved by the experiment.

7. Proper preparations should be made and adequate facilities provided to protect the experimental subject against even remote possibilities of injury, disability, or death.

8. The experiment should be conducted only by scientifically qualified persons.

9. During the course of the experiment, the human subject should be at liberty to bring the experiment to an end if he has reached the physical or mental state where continuation of the experiment seems to him to be impossible.

10. During the course of the experiment, the scientist in charge must be prepared to terminate the experiment at any stage, if he has probable cause to believe . . . that a continuation of the experiment is likely to result in injury, disability, or death to an experimental subject.

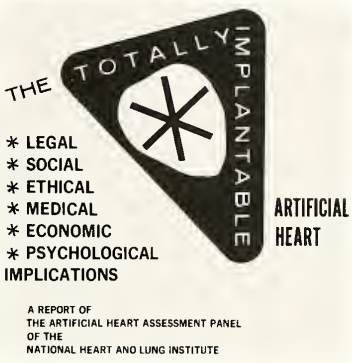
The Nuremberg Code, formulated during the war crimes trials following World War II, is the first multinational statement of modern medical ethics.

Modern Medicine and the Emergence of Biomedical Ethics

The emergence of biomedical ethics is one of the most striking trends in modern medicine. Although examining the ethical aspects of practice and research has always been an integral part of the study of medicine, that examination has traditionally been conducted by practitioners themselves and has rarely been shared with or shaped by the public. That situation has changed radically in the last twenty-five years.

Much of the narrative about biomedical ethics is dictated by new and dramatic technological developments. Yet, to a large extent, that narrative is also influenced by the very practices and events that it examines.

I identify four major topics that have aroused substantial controversy and debate: Human experimentation, resuscitation, organ transplantation, and *in vitro* fertilization. By tracing the history of each topic, I hope to illustrate the special relationship between these topics and medical ethics.



The artificial heart is among the most dramatic technological developments challenging biomedical ethicists.

Human Experimentation

The Nazi Doctors

Although criticisms of experiments on human subjects appear sporadically in the literature, there was no stated consensus on standards for such issues as voluntary consent until the revelation

by Gershon B. Grunfeld

of atrocities committed during World War II.[1]

Under the guise of scientific research, Nazi physicians were responsible for murderous experiments on hundreds of thousands of captive victims, mostly Jews, Gypsies, and Russian prisoners of war. The extent to which Nazi medicine abused human subjects in the name of science was exposed during the post-war trial of twenty Nazi doctors at Nuremberg. Summing up the ethical aspects of the different experiments, the prosecutor stated: "None of the victims of the atrocities perpetrated by these defendants were volunteers, and this is true regardless of what these unfortunate people may have said or signed before their tortures began. Most of the victims had not been condemned to death, and those who had been were not criminals, unless it be a crime to be a Jew, or a Pole, or a Gypsy, or a Russian prisoner of war."[2]

An example of research atrocities is SS doctor Sigmund Rascher, who tested the limits of human endurance with high-altitude experiments conducted at the Dachau concentration camp between March and August of 1942. In these experiments, Rascher placed subjects in a chamber in which both high-altitude atmospheric conditions and pressure were simulated. Many prisoners sustained serious injuries or died.

Rascher also supervised freezing experiments at Dachau in 1942 and 1943. As part of the experiments, prisoners were forced to be immersed in a tank of ice water for as many as three hours. Others were kept naked at sub-freezing temperatures. Survivors were forced to continue with other experiments in which different methods of restoring normal body temperatures were attempted.

When Rascher presented the results of his experiments as a thesis to fulfill the requirements for an advanced degree, he was told by a fellow SS doctor that the work would have been a disgrace even as the effort of "a second semester student." Upon examination some forty years later, the scientific value of the Nazi experiments was still judged worthless.[3]

Malaria tests were conducted at Dachau from February, 1943, through about April, 1945, by Dr. Klaus Karl Schilling, a renowned expert on the disease. During those experiments, more than one thousand healthy concentration camp prisoners were purposefully infected by malaria, and many perished as a result.

Several other notorious experiments were undertaken at Auschwitz and Birkenau. Dr. Josef Mengele conducted research on twins, especially among Jews and Gypsies. Although much of his work consisted of elaborate anthropological measurements and comparisons, he also ordered the murder of twins for autopsies. Mengele further engaged in research on dwarfs and sufferers of noma, heterochromia, and other debilities. At Auschwitz, Drs. Clauberg and Schumann performed brutal sterilization experiments involving injections, surgery, and radiation.[4]

Most of the Nazi experiments, although supervised by doctors, were essentially different in nature from

customary medical research. The experimenters were motivated by neither a desire to improve the health of patients nor a legitimate scientific curiosity; rather, they were driven by personal ambitions unchecked by a totalitarian government.[5]

From the horrors of the Nazi experiments came the first multinational statement of modern medical ethics. Although intended as a specific condemnation of concentration camp experiments, the Nuremberg Code served as a definitive statement of both participants' rights and researchers' obligations in medical experimentation. The Nuremberg judges stressed ten basic principles that must be observed in medical experiments upon human beings. The Code stressed the primacy of voluntary and informed consent, the likelihood of scientific merit, and the need to balance risks and benefits to participants.[6]

American Ethical Debate in the Postwar Period

In 1966, Dr. Henry K. Beecher stunned the American medical profession with "Ethics and Clinical Research," an article in which he listed fifty recent examples of questionable health-threatening experiments conducted on human subjects without informed consent. He drew his examples from accounts of researchers published since 1950 in respected medical journals.[7] In addition to instances of failure to provide informed consent, Beecher found the administration of placebos and withholding of known effective medication, multiple X rays on healthy infants, and numerous other practices that were ethically suspect. "Ethics and Clinical Research" is regarded as a landmark in biomedical ethics.[8]

One year later, *Human Guinea Pigs* by M. H. Pappworth detailed hundreds of other experiments in which the basic principles of safety were breached.[9] In the decade that followed, three horrendous research projects came to the public's attention as emblematic of the tragedies resulting from loose regulations and standards in the field of human experimentation.

The Jewish Chronic Disease Hospital Case

In July of 1963, physicians at the Jewish Chronic Disease Hospital in Brooklyn, New York, injected twenty-two elderly and senile patients with "live cancer cells." The experiment was designed to measure the immunologic reaction of healthy patients to foreign cells. Not only was the research completely unrelated to the patients' other health problems, but none were told the nature of the experiment or any of the risks involved. In 1964 the Jewish Chronic Disease Hospital case received wide publicity after a board member sued in order to force disclosure of treatment records. Later, directors took the hospital to court to force full disclosure of records. The Board of Regents of the State University of New York eventually suspended the medical licenses of the physicians who had initiated the experiment, Emanuel E. Mandel and Chester M. Southam.[10]

The Willowbrook Case

Life-threatening medical experimentation also took place at Willowbrook State School, a Staten Island, New York, institution for mentally retarded children. Like many such state institutions, Willowbrook had a history of health problems stemming from poor sanitation; infectious diseases were endemic. Beginning in 1956, however, and continuing for more than twenty years, administrators created an additional hazard by deliberately exposing healthy children to hepatitis. According to the investigators, "It was inevitable that susceptible children would become infected" by some contagion in the school, and since the hepatitis victims were housed in an isolated unit, they were spared exposure to contagions of the general population. Researchers also claimed a "therapeutic" benefit because patients were thus immunized for future exposures.[11]

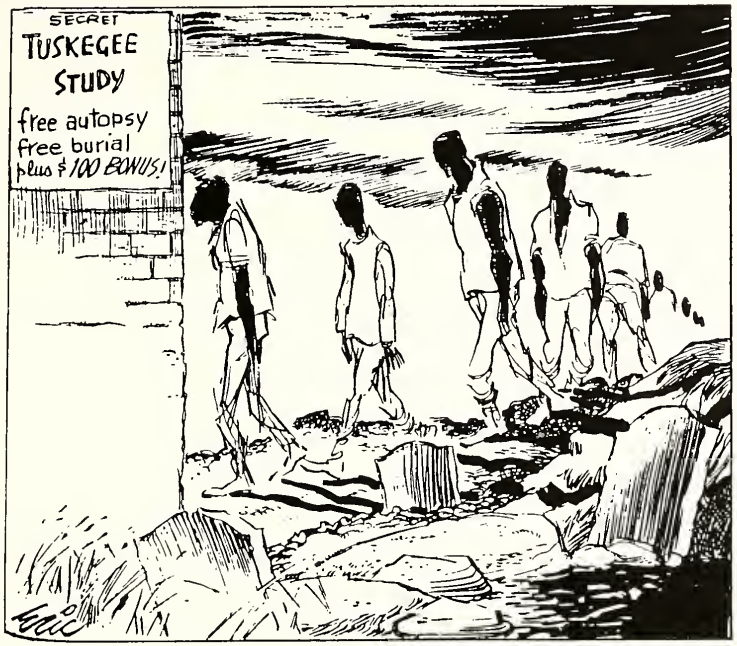
Amazingly, parents cooperated in admitting children to the study! At first, consent was obtained by letters or personal interviews; later groups of parents were given a detailed explanation of the project, tours of the facility, and interviews with physicians. Overcrowding forced administrators to halt new admissions in late 1964, but parents who applied were invited to put their children on a waiting list. The hepatitis researchers thereby recruited subjects from the waiting list whenever a new study group was needed.[12]

The Tuskegee Study

One of the most widely publicized scandals resulting from medical experimentation on human subjects was a forty-year study by the United States Public Health Service, begun in 1932, regarding the effects of untreated syphilis on black men in the town of Tuskegee and throughout Macon County, Alabama. From 1932 to 1972, the Tuskegee study involved 399 men who had tertiary—or final stage—syphilis and 201 healthy men who served as the control group. No formal protocol existed for the study, but on the basis of subject selection it seems that the Public Health Service was interested in documenting the untreated complications that accompany the late stages of the disease.

Public Health Service physicians conducted a variety of tests and medical examinations on the syphilitic men but gave no treatment to alleviate the disease. The basic procedure called for periodic blood testing and routine autopsies to supplement information obtained through clinical examinations. In return for their participation, the men received free physical examinations, rides to and from the clinics, meals on examination days, treatment for minor ailments, and a guarantee that their survivors would be given a burial stipend.[13]

Data from the study were published in a dozen articles, which appeared in such well-known and respected journals as *Public Health Reports* and *Archives of Internal Medicine*. Despite



Editorial reaction to the Tuskegee study by Lou Erickson, July 27, 1972

(The Atlanta Constitution *and* The Atlanta Journal)

that exposure, there was no professional outcry until the Tuskegee study was the subject of an Associated Press story in July of 1972, when interviews with both physicians and subjects suggested that the men were never told the true nature of their illness or the nature of the study. Some men reported that they had been threatened with loss of all benefits if they sought actual treatment.[14]

United States Senator Edward M. Kennedy initiated a series of hearings on human experimentation before the health subcommittee of the Committee on Labor and Public Welfare in early 1973. There was an immediate call for a thorough review of standards for all experiments funded by the federal government.[15]

International Review

Following the Nuremberg trials, the international ethical discourse on aspects of human experimentation developed in two distinct directions: (1) the formulation of codes and regulations issued by medical societies and government agencies, and (2) the

scholarly study of different elements of human experimentation from a philosophical point of view.

In 1964, the Eighteenth World Medical Assembly, meeting at Helsinki, adopted a set of recommendations for guiding physicians in research involving human subjects. The Declaration of Helsinki pointed out both the inherent hazards in medical practice and research and the necessity of such research to assure progress. It distinguished between two classes of human experimentation: research for therapeutic or diagnostic purposes, and research for purely scientific purposes with no direct benefit to the subject. The Declaration of Helsinki emphasized, among other issues, the importance of establishing a sound scientific basis for research involving human subjects. The writers also identified the need for review of research protocols by special committees, the correct calculation of risk and benefit, the duties of researchers, the special case of incompetent subjects, and the rights of research subjects to privacy, information, and free choice. The Helsinki standards were later expanded by the Twenty-ninth World Medical Assembly at Tokyo in 1975.[16]

Experimentation in the United States

The first formulation of clear limits on human experimentation in the United States took place in 1974, with amendments to the National Research Act and accompanying legislation.[17] (Previously, human experimentation was generally reviewed by either committees or research directors in individual research institutions.)

The Protection of Human Subjects regulations applied to all institutions engaged in research involving human subjects. The most far-reaching reform was the establishment of institutional review boards (IRB) with specific roles, structure, and authority. The regulations set detailed requirements for informed consent of research subjects, including explanations about the exact nature of the research, the risks and benefits to be expected, the alternative procedures, confidentiality of records, and compensation in case of injury.

Revisions to the regulations in 1983 significantly reinforced safeguards regarding patient autonomy in decisions about research. "Participation is voluntary," stated the regulations, "refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled."[18] The regulations applied to all institutions receiving federal funding of any kind, not simply the research project itself. As revised, the regulations also diversified membership of the institutional review boards, requiring members of both sexes, at least one member not affiliated with the institution, and at least one member "whose primary concerns are in non-scientific areas" (specifically, for example, lawyers, ethicists, or members of the clergy). The revised regulations also placed restrictions on the types of research ethically performed on prisoners

and children.[19] Amendments to the National Research Act in 1974 created the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research.

In 1979 the National Commission published *The Belmont Report,* a far-reaching analysis of both medical practice and medical research. The *Belmont Report* identified three basic ethical principles that should guide researchers: respect for persons, beneficence, and justice. The report further suggested the importance of informed consent and the assessment of risks and benefits when considering research with human subjects.[20]

In 1981 the Food and Drug Administration (FDA) formulated and published rules and regulations regarding human research in the testing of products under its jurisdiction. Regulations covered the work of institutional review boards and other entities created for the protection of human subjects.[21]

Philosophical Study

Philosophical discussions of human experimentation gained interest in the 1960s following revelations of unethical practices by a number of investigators. Some ethicists called for a halt to research on human subjects altogether, arguing that it posed unnecessary risks to subjects while deriving minimal scientific benefit. Others emphasized the importance of careful scientific groundwork in identifying disease entities, assuring diagnosis, and establishing mechanisms for further studies on therapies or possible remedies—all of which result only from research on human subjects.[22] Leon Eisenberg even argued for the responsibility of every citizen to share the risks of research in order to minimize human suffering.[23]

Philosophical discussion of human experimentation today focuses on the concept of informed consent. Since the Nuremberg trials, examination of the concept of informed consent and its implications both in medical research and practice may be the single most important contribution of ethical attention to medical experimentation on human subjects.

History of Resuscitation Methods

Although man's attempts at resuscitation are not new, dramatic technological developments in the last quarter of this century have raised significant issues for the medical ethicist.

One of the earliest references to resuscitation is found in the Bible: "And he went up and lay upon the child, and put his mouth upon his mouth, and his eyes upon his eyes, and his hands upon his hands: and he stretched himself upon the child; and the flesh of the child waxed warm. Then he returned, and walked in the house to and fro; and went up and stretched himself upon him: and the child sneezed seven times, and the child opened his eyes" (Kings II, 4, 34-35).

In 1472 Bagellardus issued this advice to midwives: "If she finds (the newborn) warm, not black, she should blow into its mouth, if it has no respiration or

to its anus."[24] In 1543 Vesalius offered this technique for reviving an experimental animal:

> But that life may in a manner of speaking be restored to the animal, an opening must be attempted in the trunk of the trachea, into which a tube of reed or cane should be put; you will then blow into this, so that the lung may rise again and the animal take in air. Indeed, with a slight breath in the case of this living animal the lung will swell to the full extent of the thoracic cavity, and the heart become strong and exhibit a wondrous variety of motions. So, with the lung inflated once and second time, you examine the motion of the heart by sight and touch as much as you wish.[25]

Anecdotal descriptions of artificial respiration continued throughout the next two centuries, but not until the eighteenth century did medical interest in the subject become acute when drowning became a major public and medical issue.

In 1740, the Academie des Sciences of Paris issued an "Avis" recommending mouth-to-mouth resuscitation as the best method for recovering drowned persons.[26] A number of cases describing the use of mouth-to-mouth respiration appeared in the professional literature in the latter half of the eighteenth century. Soon mouth-to-mouth respiration was competing with what could be viewed as the predecessor of the modern respirator, bellows. Following the discoveries of carbon dioxide and oxygen, positive pressure ventilation by mechanical means replaced mouth-to-mouth respiration as the preferred mode of resuscitation. The first "tank respirator" was invented by J. Dalziel and described by him in 1838.[27] The tank respirator worked by exerting negative (subatmospheric) pressure on the chest, thus causing the higher pressure of air to penetrate the lungs through the trachea, causing respiration. Several types of tank respirators followed Dalziel's invention, including a model developed for newborns.[28]

Manual methods of resuscitation prevailed for the drowned through the nineteenth and the first half of the twentieth century. In fact, several competing methods were developed; among the most popular were the Schafer method and the Nielsen method.[29] Interest in tank respirators resumed during the first half of the twentieth century when they were successful in maintaining victims of poliomyelitis.[30] Mouth-to-mouth respiration—although currently recognized as the most efficient method—did not receive that recognition until 1958.[31]

The predecessor of the modern automatic ventilator was first described in 1879-1880 for use in physiology by Henry Pickering Bowditch, who wrote: "The most perfect method of keeping an animal alive by artificial respiration is doubtless by means of bellows driven by a steam, gas or water motor. Where power of this sort is not to be had the object can be accomplished by breaking up the steady stream of air supplied by a water bellows, or tromp, into a succession of impulses following each

other at a rate corresponding to the normal respiratory movements of the animal."[32] This method, when combined with endotracheal tubes, became the preferred method of ventilation for maintaining anesthetized patients during surgery.

The European poliomyelitis epidemic of the 1950s, during which large number of patients suffered from bulbar paralysis, emphasized the need for an efficient automatic method of artificial respiration. A number of positive-pressure machines were developed to meet that crisis, and positive pressure continues to be the most accepted method of artificial respiration.[33]

Cardiopulmonary Resuscitation

Cardiopulmonary Resuscitation—or CPR as we know it today—has been in practice only since the early 1960s. It is not surprising, therefore, that many troubling questions involving CPR remain. At first, CPR was viewed as the ultimate medical innovation. People suffering cardiac arrest outside the hospital were not doomed to die but could be saved by three easily-learned steps.

CPR also revolutionized resuscitation efforts in hospitals. Before 1960, the only method acceptable for resuscitation of cardiac arrests was open-heart massage, which meant that only surgeons, mostly in operating rooms, were able to save arresting patients. With CPR, any trained physician or nurse could initiate resuscitative measures.

The enthusiasm about the new life-saving method pushed aside customary medical judgment. Attempting to resuscitate anyone who suffered apnea or cardiac arrest created a situation in which terminally ill patients could be resuscitated at a stage that did not enhance their quality of life or dignity but only lengthened their suffering and dying. Resuscitative efforts could even result in a Persistent Vegetative State (PVS) because the heart has a greater tolerance to hypoxia than the brain.[34]

The President's Commission for the Study of Ethical Problems

Ethical questions raised by the effects of CPR when combined with life-support systems were brought to the attention of the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research, which issued *Deciding to Forgo Life-Sustaining Treatment* in March of 1983.[35] Members stressed the right of the competent patient to decide whether to accept life-sustaining therapy. At the same time, the commission stated clearly that "health care professionals or institutions may decline to provide a particular option because that choice would violate their conscience or professional judgment, though in doing so they may not abandon a patient."[36] (The availability of options to the patient may also be restricted because of considerations of effective or equal use of limited resources.)

On the administration of CPR, however, the commission did make an ethical distinction. In the event of "unexpected cardiac arrest," the commission recommended "a presumption favoring resuscitation."[37] In cases

of expected cardiac arrest, however, either the competent patient or the patient's surrogate is entitled to refuse resuscitative measures. If arrest is expected, the patient should be given the opportunity to choose for or against resuscitation. A Do-Not-Resuscitate (DNR) order should be clearly documented in the chart.

Although the commission stressed that it was the physician's duty to "assess for each hospitalized patient whether resuscitation is likely, on balance, to benefit the patient, to fail to benefit, or to have uncertain effect," it left the ultimate decision in the hands of the competent patient, even if that decision conflicted with the physician's judgment. According to the commission: "A DNR order should be entered in the patient's hospital chart only after the patient has decided that is what he or she wants."[38] The physician thus has the option of withdrawing from the case. In the case of conflicts with surrogates of incompetent patients, the physician has the added option of turning to the judicial system for aid. The commission rejected the suggestion by the senior attorney of the National Institutes of Health that a patient's consent to a DNR order is not needed in cases where resuscitation is not a feasible treatment.[39]

Ethical Considerations in the Hospital

DNR orders have been considered for age, severe brain damage, and intolerable suffering or disability.[40]

Two of the most crucial ethical questions faced by physicians and house staff in dealing with DNR issues are: (1) Should the patient be consulted before a DNR order is written? and (2) Should complicated treatment be continued after a DNR order has been written? Examining the rationales for writing DNR orders is one way of minimizing the ethical difficulties.

No Medical Benefit. A DNR order may be written if resuscitation is not likely to be successful.

Poor Quality of Life After CPR. A DNR order may be written if the patient's likely quality of life after CPR is unacceptable, even if the patient's life may be lengthened.

Poor Quality of Life Before CPR. A DNR order may be appropriate if the patient's current quality of life is judged unacceptable even before any expected need for resuscitation.[41]

What are the implications of each of those rationales on the weight given to patient's values as well as to the continuation of other treatments?

If CPR has no medical benefit to the patient, the wishes of the patient or the patient's family wishes are irrelevant. CPR will do the patient no good. Under those circumstances the physician should inform the patient or family about the decision to write a DNR order but not give it to them as a choice to be made. But the judgment that CPR will not do the patient any good may still be consistent with continuing other treatments. Thus, in this case it does not have any necessary implications for other treatments.

When the rationale for DNR is the patient's quality of life before or after treatment, the patient should evaluate

the benefits and costs of CPR, taking into account the medical judgment by the physician. When the rationale for DNR is poor quality of life after CPR, there may be no necessary implications regarding other treatments. When the rationale is poor quality of life before CPR, however, and the patient does not wish to prolong life, the situation is quite different. Then, as two ethicists have stated, "the same logic that supports DNR orders also supports the withholding or withdrawing of other life-prolonging measures."[42]

Among the many ethical issues that resuscitation medicine has brought to the attention of both the public and members of the medical profession are the definition of death, withholding and withdrawing treatment, adequate care for the terminally ill, the right for death with dignity, and the issue of medical futility. Public attention to these issues has found its expression in the law. Most state legislatures have provided for living wills and durable power of attorney, thus allowing the public more freedom in deciding their treatment in times of terminal illness or incapacitation.

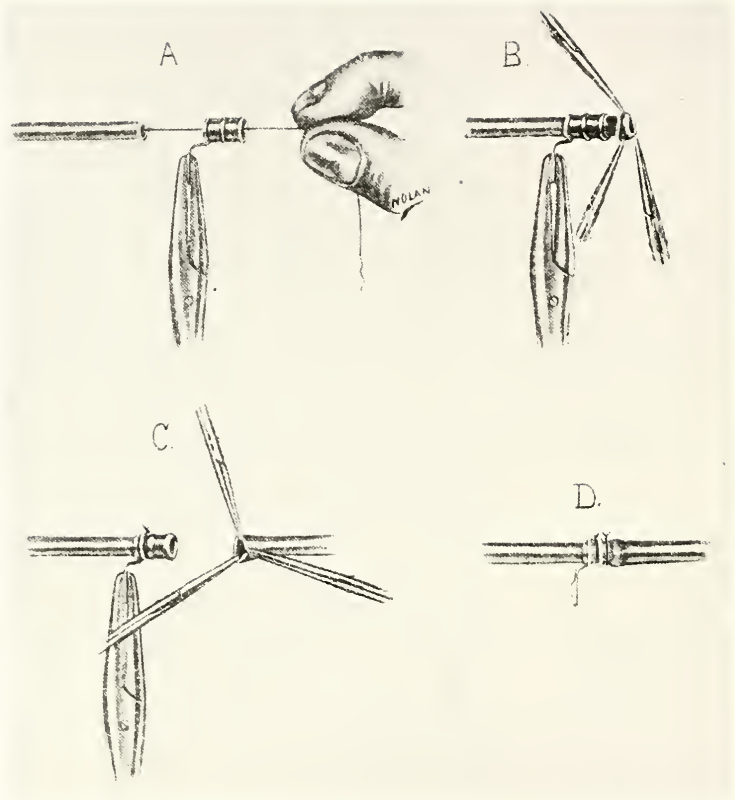
Organ Transplantation

Blood is probably the human organ with the longest history in transplantation. The earliest documented case of a blood transfusion is that given to Pope Innocent VII. In April, 1492, when he was gravely ill, the Pope was transfused by the blood of three young boys. As a result, all three boys died without bringing any relief to the Pope.[43]

Although the first detailed description of blood transfusion appears in the early seventeenth century in the writings of Andreas Libarius of Hale in

Early attempt at blood transfusion from animal to man

***(M. G. Purmann,* Der rechte und warhafftige Feldscher)**



Diagrams of stages of end-to-end anastomosis of two blood vessels by the Cannula Method, as portrayed in George Crile's 1909 classic Hemorrhage and Transfusion: *"A. Pulling the vein through the cannula. B. Cuffing back the vein over the cannula with three mosquito hemostats. C. The vein cuffed and tied in place in the groove next to the handle of the cannula. The artery is ready to be drawn over the vein. D. The anastomosis completed, and the cannula hemostat removed. The artery is tied in the remaining groove. The short handle of the cannula is so light in weight that it does not cause torsion of the vessels" (p. 292).*

Saxony, not until the late nineteenth century and early years of the twentieth century were the two major obstacles to successful blood transfusions overcome. First, the Swiss physiologist Nicolas Maurice Arthus discovered in 1890 that adding a small quantity of soluble salt of oxalic acid (citrate) to blood would prevent it from clotting when exposed to the air. Since citrate is relatively nontoxic, that finding allowed for the first successful preservation of blood outside the body. Second, Karl Landsteiner's discovery of the major groups of blood (O, A, and B) in 1902 allowed for much safer blood transfusions by reducing the risk of agglutination. But it was not until eleven years after Landsteiner's discovery that blood was tested before transfusion.

A third important development in the early twentieth century was the perfection of the vascular anastomosis technique perfected by Alexis Carrel. The same technique is used today for the connection of blood vessels in organ transplants. Carrel first developed his technique through experimental kidney transplants in dogs and cats.[44] Not until the twentieth century were other organs also considered for transplantations.

The first documented successful human kidney transplantation was performed by Drs. Hufnagel, Landsteiner, and Hume at Brigham Hospital, Boston, in 1947. Their patient was a young pregnant woman who had developed an infection in the uterus followed by severe shock. After ten days without producing urine, she fell into a deep coma; her death was imminent. At the request of her physician, Dr. Hufnagel agreed to try grafting a kidney. A kidney was obtained from a cadaver and was connected to a large artery and vein in the women's arm, only partially buried under her skin. The kidney started excreting urine soon after it was connected, and continued functioning for two days until it showed clear signs of rejection and was removed. By that time the woman exhibited remarkable improvement, including the recovery of her own kidney function. This method of short-term kidney transplants continued until the more efficient dialysis machine was developed.[45]

Number of Patients on Dialysis or Receiving Kidney Transplants, 1951-1980

Year	Patients undergoing dialysis	Kidney transplants performed
1951-1962	—	75
1963	—	163
1964	—	239
1965	300	305
1970	2,456	1,091
		(1,460)*
1975	22,000	3,730
1980	53,364	4,697

***This number reflects discrepancies in the literature.**

SOURCE: U.S. Department of Health and Human Services, *Health Care Financing: Findings from the National Kidney Dialysis and Kidney Transplantation Study* (Baltimore, MD: Office of Research and Demonstrations, 1987), p. 23.

Still, the greatest obstacle to successful organ transplantations was not cleared until many years later when physicians recognized, understood, and found ways to overcome the body's immunological rejection. The work of Sir Macfarlane Burnet of Australia in the 1940s and 1950s—along with that of Drs. Billingham, Brent, and Medawar in London in the 50s—paved the road to this achievement.

An important milestone in the development of kidney transplantation was the dialysis machine. During the Second World War, Dr. W. J. Kolff, working in Holland, produced the prototype for a dialysis machine. He used long cellophane tubings originally manufactured for sausage casting immersed in a salt solution. Kolff brought the blueprints of his machine to the United States where it was developed further at Brigham Hospital and named the Kolff-Brigham kidney. The machine revolutionized treatment for sufferers of acute kidney failure because it allowed the kidneys enough time to recover their normal functioning. But for patients with chronic kidney failure, the dialysis machine was only a temporary solution; more lasting relief was found in the form of kidney transplantation.[46]

The state of the science of transplantation in the early fifties was such that the anatomic and physiologic aspects of rejection were understood but not overcome. The only good candidates for long-term transplantation were individuals lucky enough to have an identical twin. On December 23, 1954, a team of surgeons at Brigham Hospital performed the first operation transplanting a kidney from one identical twin to the other. The recipient fully recovered from the operation and returned to normal activity.[47] He died eight years later of coronary artery disease.

In the years that followed, dozens of similar transplantations were performed in the United States, Canada, and Europe; the majority extended the life of recipients by years. In the next twenty years, scientists of transplantation continued to search for the tool that would break the natural rejection mechanism of the body and open the possibility of transplantation between people not genetically identical. Among the measures that were tried with very limited success were whole-body irradiation and such drugs as 6-mercaptopurine, azaserine, actinomycin, and cortisone. During the late sixties, amid advances in tissue-typing and matching for compatibility, attempts were made to transplant other large organs. In 1963 Dr. Thomas E. Starzl in Denver performed the first human liver transplant. Five other transplants followed, yet in all cases, the patients died within a few weeks.

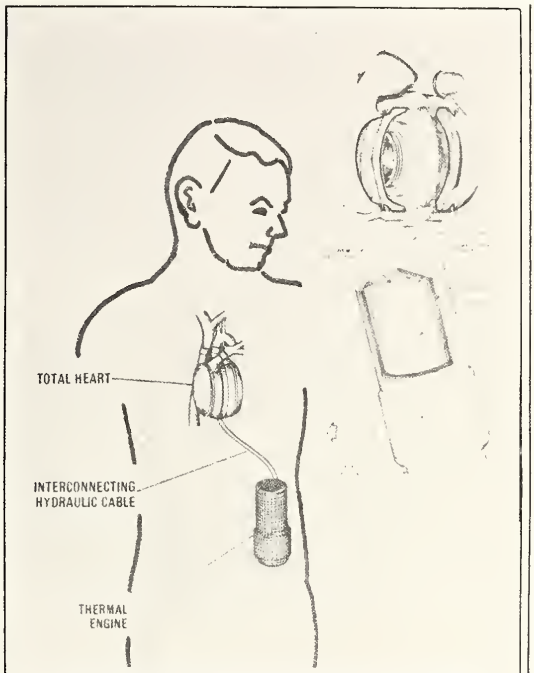
In November of 1967, Dr. Christian Barnard caught the world's attention when he performed the first heart transplant in South Africa. Although that recipient lived only a few days, more than one hundred heart transplants were performed in 1967 and 1968 in different medical centers in the United States, Europe, and South Africa. Very few of those patients survived beyond a few weeks or months, however, and by 1969 there was a sharp decline in the number of heart transplants performed.

The story of heart transplants clearly demonstrated the discrepancy between the technical achievement of medicine and the theoretical understanding of immunological functioning.

In the mid-70s a new drug, Cyclosporine, was tested in Europe and the United States as an immunosuppressant agent. In the view of many, this drug offered promise for a much wider and more successful application of transplanting techniques. Combined with a marked improvement in the technical abilities of medicine, life-sustaining machinery, accurate tissue typing, and more, the science of transplantation experienced a renaissance limited only by the scarcity of donated organs.

Organ transplantation raised many difficult ethical dilemmas, however, only some of which will be reviewed here. The development of the kidney dialysis machine was probably the first medical development that focused public attention on the issue of allocation of scarce resources. At a time when few dialysis machines were available and a large number of patients could have benefited from them, a decision had to be made as to who would have access to this lifesaving technology.

At Swedish Hospital in Seattle, Washington, a citizen committee (popularly known as the "God Squad") determined access, thereby deciding who would live and who would die.[48] The dialysis machine dilemma was finally solved when Congress decided to fund such technology for all who needed it. But similar problems remain unsolved and call for careful examination of our concepts of justice. There are many situations, for example, in which more than one patient is competing for a single lifesaving organ. The same dilemma is raised on a much larger scale considering the allocation of resources in our medical system as a whole.[49]



A NUCLEAR-POWERED HEART THAT WILL NOT REQUIRE RECHARGING — CURRENTLY UNDER ENGINEERING DESIGN AND DEVELOPMENT (NUCLEAR ENGINE IS IN ANIMAL TESTING PHASE).

Prototype for a nuclear-powered artificial heart, from a 1973 publication of the National Heart and Lung Institute

Organ transplantation has challenged the ancient principle of "First, do not harm." Throughout history, drugs have had severe side effects. Until the discovery of sterile procedures and safe anesthetics, for example, most surgeries involved great harm for patients, and often led to death. The justification for such procedures was usually that the person endangered by medicine would benefit if the therapy was successful; thus, on balance the potential benefit would outweigh the danger. Organ transplantation has made this justification inadequate, however. In the case of living donors, a healthy bystander might be harmed in order to benefit the patient. The first attempts at organ transplantation illustrated the problem vividly. The traditional "Do no harm" was replaced by a question of probabilities: "What is the likelihood of harm being done, as opposed to the likelihood of good accruing to the patient?" In the words of one ethicist, the "ethical dogma" was replaced by a "probabilistic calculus."[50]

Progress in the field of transplantation also enhanced other philosophical discussions. In the beginning, cadavers were a major source of organs, but not until heart transplantation did the traditional definition of death (focusing on heart and lung function) came in for serious review. After all, how can we harvest a beating heart from a human being? A revision in the definition of death was discussed and suggested in 1968 by a committee at Harvard Medical School.[51] Since then, brain death has become accepted as an alternative to the traditional definition of death. The revision of the definition of death and the philosophical examination of that definition may be the major mark that the development of the science of organ transplantation has left on biomedical ethics.

New Reproductive Techniques

The question of fertility has probably always been a major concern of mankind. Evidence of man's concern with fertility can be found in artifacts dating back to the ice age, as evidenced by the ancient image of Venus of Willendorf. One of the most ancient attempts to understand fertility is found in the Egyptian culture. Among several papyruses that address the fertility issue are the Kahoun papyrus (circa 2000 BC), which contains discussions of two fertility goddesses (Anuquet and Isis) as well as an analysis of the female anatomy and some gynecological diagnoses and treatments. During the same period the importance of fertility is emphasized in the Mesopotamian civilization. The Code of Hammurabi contains both monetary and personal penalties for striking a woman and causing her to miscarry. Numerous references to the issue of fertility and infertility are found in the Bible, including the stories of Hagar, Jacob, Leah, Rachel, and Abraham and Sarah.[52]

One expression of Greek interest in fertility is found in the Hippocratic writings, where description of possible causes and diagnosis of infertility are

found. Detailed explanations of the reproductions process in the living world are also found in Aristotle's *Generation of Animals*. Gynecology as a specialty was well established by Greek medicine in the first century AD. During the second century AD, Suranus, considered to be the father of gynecology, practiced in Rome. His *Gynecology* was the authoritative text on women's diseases. Very little new knowledge about human reproduction was discovered during the Middle Ages. In the early Renaissance period, Greek ideas about the anatomy of human reproductive organs and conception are identifiable in the drawings of Leonardo da Vinci.[53] The Renaissance brought great gains in our knowledge of human reproduction and anatomy. During the seventeenth century, Gabriele Falloppius, teaching at the Medical School of Padua, named and suggested the functions of the fallopian tubes, clitoris, vagina, and placenta.[54] During the same period, Reinier de Graaf in Holland refuted Aristotle's theory that conception occurred when semen mixed with the egg in the menstrual flow. Anton Leeuwenhoek's invention of the microscope in the eighteenth century enabled a new stage in understanding human reproduction. The Ialian Spallanzani was the first to describe the process of fertilization, discarding the theory that vapors in the semen fertilized eggs.

The late nineteenth century marked the beginning of modern scientific treatment of reproduction and fertility, bringing into consideration not only anatomical but also hormonal and other factors. The beginning of American gynecology is marked by J. Marion Sims's *Clinical Notes on Uterine Surgery with Special Reference to the Management of the Sterile Condition*, published in 1866.[55] During the early decades of the twentieth century further advances were made in reproductive endocrinology with the discovery of estrogen and progesterone as well as advances in surgical techniques. Not until the late 1970s was the true breakthrough made with *in vitro* fertilization (IVF). Also known as the test-tube technique, IVF involves removing eggs from a female, fertilizing them outside the body with sperm, and then replacing them in the uterus to grow and develop normally.

The first test-tube baby, Louise Joy Brown, was delivered by Caesarean section on July 25, 1978. The procedure was the handiwork of two British scientists, Patrick Steptoe and Robert Edwards. Since then, IVF has been performed on thousands of women previously infertile due to fallopian tube absence or damage, severe endometriosis, immunologic infertility, or other causes.

IVF has revised long-held concepts of motherhood and parenthood (although it continues to draw criticisms from those who oppose masturbation).[56] It allows a couple or a woman to have a baby that is the result of donated sperm or egg. It opened the possibility of a "womb for hire"—i.e., a woman who carries to term a fertile egg that may not be hers. Moreover, development of multiple-ovulation techniques for IVF purposes has created a situation in which more fertilized eggs are available than are desirable for use at a single

implantation, thus enabling the storage of fertilized eggs for use at a later time.

The ability to manipulate live sperm and eggs *in vitro* opened the possibility of performing sex selection before the implantation of the fertilized egg, and by using new genetic diagnostic techniques to test the genetic fitness of the egg, sperm, and the fertilized egg. Those developments raised numerous ethical questions—the revolution that has been characterized as "32 ways to make a baby."[57] Even as *in vitro* fertilization was being perfected, there were strong moral objections raised to it. One charge was that the procedures carried a serious risk to the unborn. Suggestions to impose a moratorium on IVF research were not accepted, however, and in retrospect it seems that the facts did not support the early fears. IVF proved to be a relatively safe procedure for both the mother and the newborn, if troubling for the ethicist.[58]

The ownership of stored fertilized eggs was first challenged in a 1989 divorce case during which a couple fought over the fate of seven frozen embryos stored at a fertility clinic in Knoxville, Tennessee.[59] That case and similar ones in other states were decided judicially. But the debate continued: Who would control the fate of frozen pre-embryos? What could be done with them?[60] What is their moral status?

Opinions on those issues were largely dependent on the answer to another question: When does life begin? Many other issues have emerged:

One IVF pioneer, R. G. Edwards, has suggested using embryonic tissue

Anton Leeuwenhoek

grown *in vitro* for transplant into adults to replace bone marrow and to cure anemia, Parkinson's disease, and other illnesses.[61] The debate over ethical uses has been entered into by scores of governments and medical regulatory bodies.[62]

The development of new reproductive technologies, especially IVF, brought to the center of public debate questions regarding the status and treatment of human fetuses. The ability of modern medicine to manipulate human fetuses *in vitro* and make diagnostic tests on them also raises serious questions about societal attitudes toward newborns born with defects.

Conclusion

Many of the ethical dilemmas confronting us today in the field of

medicine. The amazing transformation of medicine in the twentieth century intensified old ethical quandaries and raised many new ones unimagined before.

Four major developments shaping the field of biomedical ethics in recent history have been described in this paper. David J. Rothman states that medicine, as we know it today, has been strongly influenced by this sudden public interest in the ethical ramifications of medical practice.[63] The public debate that started about twenty-five years ago brought into medicine lawyers, ethicists, sociologists, and others previously considered "outsiders" by the medical community. Their influence radically changed physician-patient relationships and the way medicine is practiced today.

■

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Gershon B. Grunfeld is Assistant Professor of Medical Humanities at Southern Illinois University School of Medicine in Springfield. He completed undergraduate studies at Ben-Gurion University and earned a doctorate in philosophy from the University of Tennessee.

The Critic's Perspective on the Use of Drama

The remarks printed below are taken from the author's preview of "Miss Evers' Boys," a drama based on the Tuskegee Study of Untreated Syphilis in the Negro Male. "Miss Evers' Boys" was produced between September 23 and October 27, 1991, at the Goodman Theatre of Chicago. The stories appeared in the September 15 and September 24, 1991, issues of the Chicago Sun-Times *and are reprinted with the permission of the paper.*

This fall, as part of its orientation program, Cornell University insisted that its 3,000 incoming freshmen attend a touring production of David Feldshuh's play "Miss Evers' Boys."

It was no secret that Feldshuh was a professor of theater at Cornell and artistic director of its Center for Theatre Arts, as well as a physician who practices emergency medicine at an Ithaca, New York hospital several nights each week. Yet local boosterism had nothing to do with the reason that his play was made required viewing.

Rather, it was the fact that the drama, a fictionalized account of one of the most horrifying episodes in modern medical research, is a powerful catalyst for debate on such issues as race, class, community relations, the prerogatives of scientists, the rights of patients, the state of health care, the abuses of medical research in Third World countries, the whole notion of medical ethics and above all, that most basic question: What is an individual's responsibility to other human beings?

Given the wave of intolerance sweeping across campuses these days, debate on such questions seems especially appropriate. But "Miss Evers' Boys," which premiered at the Center Stage in Baltimore in 1989, and has been reproduced at regional theaters in Minneapolis, Los Angeles and Atlanta, is a great deal more than a powerful teaching tool.

The play . . . also happens to be wonderful theater—a work filled with memorable characters, vivid storytelling and equal shares of moral outrage and compassion.

The inspiration for Feldshuh's play was "The Tuskegee Study of Untreated Syphilis in the Negro Male," the now infamous research project conducted by the U.S. Public Health Service between 1932 and 1972. The study, carried out with the Tuskegee Institute, the prestigious black school founded by Booker T. Washington, was initiated during the Depression in rural Macon County, Alabama.

by Hedy Weiss

At the time, government efforts were being made to treat syphilis, which had reached epidemic proportions. However, when funding ran out for the treatment programs, which had involved the use of such early remedies as arsenic, the Public Health Service created a stopgap study designed to monitor the progression of the *untreated* disease. And that plan gradually evolved into an insidious forty-year effort that not only kept the truth from its subjects and required them to submit to painful spinal taps, but also actively denied them a possible cure when penicillin became available in 1946.

In fact, the Tuskegee study became a secret death warrant, and its goal became to use men as human guinea pigs and "bring them to autopsy," while chronicling the slow but progressively debilitating effects of syphilis. All this was done in the name of pure science.

How could such a thing happen? It helps to know that the subjects—412 of whom were infected with syphilis and another 214 who were uninfected and used as a control group—were poor, illiterate, black sharecroppers who lived in a society where lynchings were commonplace and where resistance to white authority could be fatal. In addition, they were lured into the study with the promise of hot meals, basic medical care and a decent burial. They also were placed under the long-term supervision of a devoted black nurse, Eunice Rivers (who is the "Miss Evers" of the play's title), although in a profound but very complicated way, she ultimately betrayed them the most.

Pictured in the Goodman Theatre 1991 production of "Miss Evers' Boys" are, from left, Donald Griffin, Danny Johnson, Tab Baker, and Frederick Charles Canada.

(Courtesy of the Goodman Theatre)

The study becomes even more insidious because the men were told only that they were being tested for "bad blood," but were never warned that they could infect their wives, girlfriends and future children.

After the horrors of the study were finally exposed in 1972, a class-action suit was filed, and the federal government agreed to pay about $10 million to survivors, control subjects and heirs.

But the most important enduring outcome of the revelations was the demand for stringent "informed consent" of patients before they enter into any medical treatment or research project.

Feldshuh's play, which is based on James H. Jones' revelatory book, *Bad Blood,* as well as on Senate testimony, medical articles and field interviews conducted in Alabama in the 1930s, spans the forty years of the Tuskegee study. And it follows the fates of four men (who range in ages from nineteen to fifty-seven years of age as the play begins in 1932), the Public Health Service nurse who cared for them, a black doctor from Tuskegee and a white field physician for the Public Health Service.

Feelings of Ambivalence

"I had many ambivalent feelings while writing this play," said Feldshuh, an engaging 47-year-old man whose resume reads like the diary of a compulsive over-achiever.

> Without research, there is no progress. And there always is the argument of "the greater good for the greater number." Yet I believe that medicine should be governed spiritually by the Golden Rule that says do not do to someone else what you would not want done to yourself or someone you love. Science cannot be morally blind. And it is very important that you do not allow yourself to objectify a patient. Empathy is essential.

In this scene from "Miss Evers' Boys," Nurse Evers (played by Celeste Williams) takes her patients for a drive.

(Courtesy of the Goodman Theatre)

My play is really about the evolution of consciousness on three levels. . . . There is the component of racism. There is the idea that science has an almost inviolable right to pursue knowledge at any cost. And there is the idea, undeveloped until recently, of patients' rights. Our thinking about all of these has changed in recent decades.

David Feldshuh's quietly devastating play begins and ends as Eunice Evers, a black public health nurse, stands in a spotlight and offers testimony before a Congressional committee. Yet when Miss Evers speaks, you sense her testimony is being offered to a higher power.

In the first instance, Evers recites the oath of her profession with a pride and passion that glow with the fire of the true believer. By the end of the play, however, her testimony has become a confession. And as she digs deeply into her soul, she sees her judgment by a fantastical quartet of male dancers who strut joyfully in the background, dressed in white suits and dashing hats.

The men are a dream vision of four poor black tenant farmers who Miss Evers cared for and deceived over a 40-year period. Yet the story told in "Miss Evers' Boys" is no dream. It is a fictionalized but essentially accurate account of the medical horror story that has come down to us as "The Tuskegee Study of Untreated Syphilis in the Negro Male."

Hedy Weiss, *Chicago Sun-Times*, September 24,1991

> It's easy to say that the Tuskegee study was just one more virulent example of racism. . . . Because as we've seen, there is sometimes a valid reason for race and gender-specific research. There are diseases that tend to attack particular ethnic groups. And what's more, as recent headlines have shown, when we *don't* study particular groups, such as women, whose risk of heart disease has been underplayed, we fail, too.
>
> Yet [when] you look at this Tuskegee study, you begin to understand why among many poor people in the African-American community there is a pervasive distrust of the medical establishment and a hesitancy to seek treatment.

In writing the play, which went through a gestation period of nearly ten years, Feldshuh's main concern was to create a work that "would not be preachy, but would say something about human experience.

Asked how a white, urban, middle-class Jew could capture the speech of rural, poor black men, the playwright recalled, "I didn't feel *I* was writing it. I just heard their voices. And I guess I was too stupid at the time to think about being intimidated. But I was thrilled when, after a performance of the play in Atlanta, a black woman came up to me and said, 'You done be touched by God.'"

Born in the Bronx, the playwright was educated at Dartmouth, where he studied philosophy and pre-med. (His sister is the actress Tovah Feldshuh.) While at Dartmouth, a job as a disc jockey at a commercial radio station led to an interest in acting and he spent 1965-66 at the London Academy of Music and Dramatic Art "learning not to intellectualize everything. Our bible was a book called *Zen and the Art of Archery*."

In 1966, Feldshuh received a McKnight Fellowship to the Guthrie Theatre in Minneapolis, where he worked as an actor, and, by age 27, was named an associate director. In addition to directing theater and opera, and writing his first play, "Fables Now and Then," an adaptation of Japanese and Native American short stories, he also earned a doctorate from the University of Minnesota.

But he was restless. "I had spent more than ten years in the theater, and I felt as if I needed to be more grounded in social reality and in the community," he said.

He had already created the Guthrie's first hospital touring show, but now he decided to go all the way—enrolling at the University of Minnesota medical school, and eventually completing a residency in emergency medicine.

Striking a Nerve

"The paradox, of course, is that 'Miss Evers' Boys' seems to have struck a nerve in audiences, and, best of all, it has stimulated a lot of dialogue and discussion," he said. "Medicine has rarely supplied that kind of connection for me, although I like using the other part of my brain, I like the clarity of it and I like helping people."

"The success of this play has surprised me. But I can't really say that I have a lot of ideas for other plays, although I've been thinking about AIDS and the responsibility that patients, as well as doctors have to each other when it comes to revealing infection."

Artists Use Theater to Bridge Racial Gap

The Goodman production of "Miss Evers' Boys" is being directed by Kenny Leon, who staged the play at Atlanta's Alliance Theatre [in 1990]—the first time it was performed in the Deep South.

Leon, 35, is the artistic director of Alliance, and the only black to hold such a position at a major American regional theater. Last year, when he assumed the title, he selected "Miss Evers' Boys" as his initial production. It was a daring choice.

"Incredibly, this show, this story of black men and syphilis, became the hit of the season," Leon said. "And it was great to see how theater actually brought the city together.

"One of the strengths of the play is that it shows that many different people made bad decisions, but it doesn't point fingers. And it suggests that we now have the power to do better."

As rehearsals got under way at Goodman, tensions erupted between blacks and Jews in the Crown Heights section of Brooklyn. David Feldshuh, the Jewish playwright, and Kenny Leon, the black director, sat down together to imagine the ways in which they could use theater to defuse the situation there.

Feldshuh thought he would stage a production of Shakespeare's "Merchant of Venice," but with reverse casting, so that the blacks would play the Jews and the Jews would play the Christians.

Leon, who has staged theater with senior citizens and the homeless, suggested going into the community and "just listening to all the people talk." Then, in conjunction with a playwright, director and musicians, "we could create something from what we've heard."

"Sometimes our perceptions of the issues are very different from what they really are," Leon said.

A Medical Horror Comes Alive

Feldshuh, both a physician and a theater director, has not written a docudrama. Rather, he has created a morality play full of ambiguity, and he has replaced statistics and debates on medical ethics with that most convincing of all evidence—flesh-and-blood human beings we come to care about.

■

Hedy Weiss has been Theater Critic of the* Chicago Sun-Times *for the past seven years, reporting on local, national, and international productions. She also writes frequently about art, dance, music, books, and travel for the* Sun-Times *and other publications.

The Radical Gesture
The Use of Drama as a Museologic Technique

"The American museum does not simply exhibit; it teaches as well."
—Commission on Museums for a New Century, *1984*

In January of 1990, the *New York Times Magazine* carried a curious article by William H. Honan entitled, "Say Goodbye to the Stuffed Elephants."[2] Using the competing visions of John Terrell's anthropology and Michael Spock's public programs departments at the Field Museum of Chicago as the focus, Honan recounts a story of unusual power and drama, a story of internecine warfare rocking American museums today. As Honan reminds us, such wars (in the case of the Field, coming to a head over the development of the "Traveling the Pacific" exhibit) are daily waged in such real-life settings as the Field Museum and in the pages of such scholarly publications as the *International Journal of Museum Management and Curatorship*. At the root of the battle is a basic disagreement about the function of museums in modern life.

While museums in general seem unlikely places for warfare, natural history and science museums seem especially so. Museums devoted to science have a musty tradition, one that has assumed that their central mission should be the collection and preservation of artifacts. There has been widespread agreement that artifacts documenting the processes of natural and scientific history are worth collecting; in fact, there has long been a belief that these same artifacts, appropriately mounted and displayed, will tell their own tales wisely and well. A growing cadre of museum professionals, however, are openly questioning whether traditional museum displays are effective. Such critics have even begun to suggest that the objects themselves may be the wrong basis for a museum collection. In an essay entitled, "Museums, Artefacts, and Meanings," British writer Charles Saumarez Smith argues, for example, that the act of preserving an artifact changes it, that the act of displaying an artifact limits its meaning, and that the act of studying it has moved museum scholarship out of the mainstream of the humanities and into a methodological backwater.[3]

Traditional definitions of museums do little to help resolve the conflict. From the time that the word for museum was applied to that part of the

by Phillip V. Davis

The centerpiece of the "Traveling the Pacific" exhibit of the Field Museum is a full-scale recreation of a Pacific coral island based on an islet in the Marshall Islands about 2,600 miles from Hawaii. Visitors to the exhibit wander across the island from its ocean front, through a mid-island forest, to the peaceful lagoon beach pictured above.

(Courtesy Field Museum of Natural History, Chicago. Neg. 111129)

Palace at Alexandria containing the Library, to the founding of the great European museums of the middle eighteenth century, the institutions have retained both preservation and education as parts of their defined roles. Today there is little debate that museums exist to acquire, preserve, study, and exhibit works of artistic, historical, or scientific value. There is considerable debate, however, about which function should guide museum operations. In the United States, the debate is still further complicated by democratic ideals that demand that public institutions fulfill public service missions.

The experience of the Field Museum in developing the "Traveling the Pacific" exhibit is emblematic of the larger controversy. While members of Michael Spock's public programs department were concerned with telling a story in a way that museum visitors could understand, members of John Terrell's anthropology department objected to an emphasis on what they considered a far less important part of the Field collection. The public programs staff were concerned that visitors interact with the material exhibited; the anthropology department, with showcasing its holdings. Honan quoted Terrell with an especially telling remark: "[W]e have 36,000 artifacts in our Melanesian collection, which is known the world over and will be given only token representation in this exhibit."[4] On one hand, the paramount importance of the historical function of a museum as a place where cultural artifacts can be collected and preserved for scholarly research provides a powerful rationale for cherishing the status quo. On the other, the widely recognized function of museums as institutions where public education takes place demands an increased emphasis on effective educational programming.

The embroglio in which the Field Museum found itself has an earlier analogue in the battle between art "appreciation" and art "interpretation" that polarized art curators of decades passed. For art museums, the battle cry began with the advent of "modern" art. As the pieces collected in art museums became less and less representational (and, therefore, less and less accessible to the general public), curators began struggling with what the museum function should be in educating the public. One of the earliest museums to enter the fray was the Art Institute of Chicago.

In 1939, Daniel Catton Rich, newly appointed director of the Institute, opened the Gallery of Art Interpretation, the country's first permanent museum interpretive space for adults.[5] Through the next twenty years, Rich set the tone for the gallery through both his personal influence over its exhibits and through his appointment in 1943 of Katharine Kuh as curator. A pioneer educator in the world of art museums, Kuh designed and mounted twelve exhibits between 1944 and 1952 that were consciously aimed at "teaching" the public about modern art.

The impact of Kuh's exhibits was enormous. They attracted national attention in both the popular and professional press. As early as 1946, Grace L. McCann Morley, director of the San Francisco Museum of Art, praised

them for readers of *Art in America* as examples of the educational possibilities inherent in museums. Kuh's sense of purpose for those exhibits put education clearly at the fore.

Kuh's exhibits represented a radical departure from more traditional techniques of interpretation. Art museums had long catalogued and displayed works grouped by artist, medium, and year. Instead, Kuh organized shows that sought to "make manifest" the origins of contemporary art, that contrasted and paralleled the way in which the masters, old and new, used color and form and space. Her intent was to help the museum visitor understand what he or she saw—to be able to interpret as well as appreciate the artifacts on display. What was less clear was Kuh's personal agenda—her concern that the public learn to accept and appreciate contemporary art.

The designer's personal agenda for an exhibit is often obscure. *What* is displayed clearly influences public response to an exhibit (readily demonstrated by the response to the Louvre loan of the *Mona Lisa* to the National Gallery of Art in 1963).[6] *How* art is displayed will similarly affect response. Looking through the lenses of a modern microscope and a van Leeuwenhoek model, for example, gives a markedly different understanding of scientific progress than simply looking at the two instruments themselves. *Why* an exhibit is mounted, however, and why it is designed in the way it is, are also of critical importance in affecting the viewer's response.

Peter Vergo's recent essay "The Reticent Object" considers the curator's perspective on museum exhibits. "Most of us," according to Vergo, "share some notion that, through the medium of exhibitions, we are *addressing* the visitor . . . and we also tend to believe that the people who go to exhibitions 'get something out of them.'"[7] Vergo argues that the educative function of museum exhibits is largely a modern understanding of the function of museums and one of little interest to the curators of the past. He explores the intentionality of education in museum exhibits through a discussion of the 1937 "Degenerate Art" exhibit organized by the Nazis. The exhibition, which toured major German cities, was intended as a condemnation of the leading Expressionists, but in the process it provided a breathtaking display of the scope of contemporary German art. Paintings were grouped to illustrate thematic concerns—the undermining of religious beliefs, distortion of color and form, even a comparison of modern art with that created by the mentally incompetent. To underscore the point, the organizers hung quotations from Hitler and other Nazi slogans and texts throughout the exhibit. Vergo judges "Degenerate Art" as "one of the most elaborately conceived, carefully-thought-out 'educational' exhibitions ever staged."[8]

Vergo concedes that while such overtly political motives may not occur often, other unexamined attitudes can well exert an influence on the kinds of exhibits produced. He cautions us to consider what guides the design of an exhibit as a way to gauge its success.

An even more basic issue had been raised by Linda Nochlin twenty years ago in her sociopolitical history of the Louvre, "Museums and Radicals: A History of Emergencies."[9] Nochlin questioned the underlying attitudes that guided the creation of museums and asks if those attitudes have changed over time. She noted that the function of the Louvre was, from the start, "conceived of as an instrument of cultural reintegration on a higher level, a means of spreading historical and aesthetic knowledge among an ever-broadening segment of society, allowing to all a share of the cultural manna which had formerly been the food of a privileged few."[10] In Nochlin's view, the works of art collected in the Louvre were spared the excesses of France's political upheavals because each generation of radicals found value in protecting the cultural artifacts collected there. Each generation sought not so much to overthrow the bourgeois culture (or the aristocratic culture of an earlier era) as to make the advantages of the privileged classes available to all.

Nochlin suggested that what is most important about museum collections is what lies behind them, not the objects themselves. She not only quite directly questioned whether museums have examined their reasons for being, but even predicted that the next revolution in museology—to paraphrase Raymonde Moulin—would question whether we want everyone to have culture or whether culture itself must be destroyed.

By 1989, Vergo was not seriously considering the museum's *raison d'être;* he was interested in the objects displayed there.[11] Vergo may be content with a cautionary tale because Nochlin's promised revolution has been neutered through bureaucratic assimilation. The Task Force on Museum Education report, *Excellence and Equity: Education and the Public Dimension of Museums,* for example, seems to acknowledge the rightfulness of Moulin's cultural challenge. Implicit in the Task Force recommendations is a recognition that museums have been "Eurocentric institutions based in Western values" that have "excluded many people from participating."[12] Museums in the western world have told, for the most part, the story of white men, their progress and their conquests. The Task Force report recommends instead that museums

- Reflect the diversity of our society by establishing and maintaining the broadest possible public dimension for the museum.
- Enrich our knowledge, understanding, and appreciation of our collections and of the variety of cultures and ideas they represent and evoke.
- Assure that the interpretive process manifests a variety in cultural and intellectual perspectives and reflects an appreciation for the diversity of museums' publics.[13]

The Task Force recommendations present a serious challenge to traditional techniques for exhibit interpretation used in most museums. Bryan Robertson's "The Museum and the Democratic Fallacy" makes the point with acerbic insight: "Only an

exceedingly small proportion of those who enter a museum are even remotely prepared for what awaits them, and only a total revolution in our educational system could remedy this deficiency."[14] It follows that it is easier to change the museum than to change its public. The approaches of Katharine Kuh at the Art Institute and Michael Spock at the Field Museum seem powerfully persuasive.

Yet, Kuh's exhibits engaged only a public interested in learning about modern art. The exhibits differed from the standard "label and object" display in approach rather than in actual technique. Exhibit goers were still asked to read labels and to proceed through the exhibition in some particular sequence. Visitors were intellectually engaged by doing what the label directed—comparing one painting with another, contrasting the effects of the addition or deletion of color, and similar tasks. Spock's approach at the Field Museum (and earlier at Boston's Children's Museum) took a different direction—immersing all visitors in the experience by recreating a Pacific atoll or an Egyptian pyramid and putting the visitor in it. The exhibits were "interactive" insofar as visitors could manipulate parts of the physical exhibit or work with computerized simulations. Both strategies moved beyond passive interpretive techniques in an attempt to engage the visitor's thought processes.

Not surprisingly, attention to interpretive techniques—which keep the visitor as the focus—parallels a changing understanding of museums. The concern of the private collectors whose artifacts formed the basis of the early museums was with the object itself and its personal significance. As those collections became public holdings, however, personal significance lost its importance as an organizing principle. Interpretation became necessary.

The most basic interpretive techniques are concerned with identification of objects. Labels, for example, are routinely used to identify an object's geographic and temporal origins. Similarly, grouping objects together is an identification technique (powerfully illustrated by the fact that art, natural history, and science museums have developed as separate entities). Insofar as museum holdings

Curator Barbara Mason presents a historical monologue to young visitors at The Pearson Museum in Springfield, Illinois.

(Courtesy The Pearson Museum)

are seen primarily as research collections, these techniques generally suffice. As the concept of the museum as a forum for education has become more persuasive, however, other interpretive techniques have become necessary in order to engage the interest and answer the questions of a less knowledgeable public.

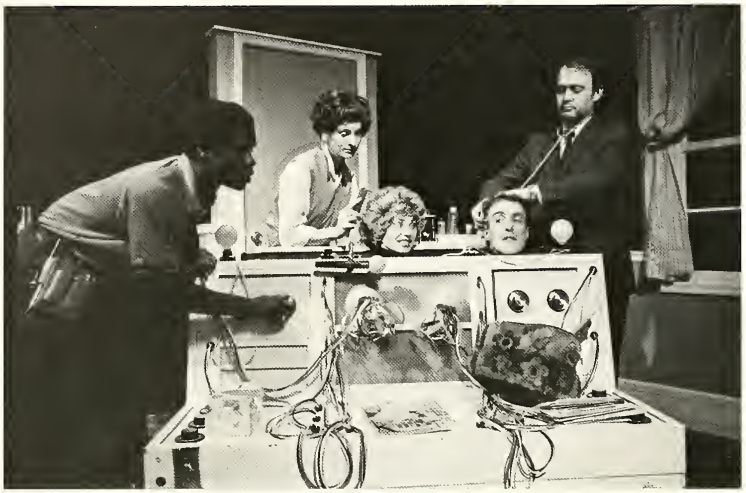
The range of techniques adopted by museums to help interpret their collections is impressive. Technological approaches vary from audiophones that obviate the need to read labels to sophisticated interactive computer systems that engage the visitor's problem-solving skills. Manipulative exhibits illustrating the principles of science and technology have been extremely effective in children's museums. Film and videotape have expanded the possibilities. (The sensation of flight provided through the Smithsonian IMAX presentation *To Fly* is a ready example.)

Technological approaches, however, represent only a part of the armamentarium of interpretive techniques. "Softer" strategies include the use of docents who explain exhibits, demonstrators who show how particular artifacts are used, and site interpreters who function as both demonstrators and docents in period costume.

Lecturers, guest speakers, brochures, and the entire gamut of traditional educational activities are used to supplement exhibits. Few stops have been left unpulled as museums have sought ways to engage public interest and promote public education. One particularly interesting development has been the use of theater.

Drama as an interpretive technique for museums began in the early 1970s with the work done by Sondra Quinn at the Science Museum of Minnesota, and has since then come of age.[15] Tessa Bridal, current director of the Theatre Department, describes the rationale for using theater in a special issue of the *Journal of Museum Education* devoted to "The Museum as a Social Instrument." She writes: "I use theatre to interpret the museum's exhibits . . . . [B]ehind every object on display are the people who made it, used it, or were affected by it. Through theatre, we can bring those people to life, and by doing so we can spark greater interest in the object itself."[16] A number of pieces developed by the Science Museum do just that. In "A Visit with Dr. Blackwell," for example, an actress dressed as a gentlewoman in Victorian America surprises museum visitors who stop to examine an anatomical display in the biology hall. "Dr. Blackwell" introduces herself and uses the objects on display to talk about the differences between medical training in her time and medical training today.

Such monologues as the Dr. Blackwell piece push the traditional role of a site interpreter into a more aggressive and interactive stance. Other theater efforts at Minnesota have pushed traditional interpretive technique even further. The department has mounted Kurt Vonnegut's *Fortitude*, a one-act play about the limits of medical technology. Staff have used specially commissioned plays to supplement



Science Museum of Minnesota production of Kurt Vonnegut's **Fortitude**

(Courtesy Science Museum of Minnesota)

exhibits with subject matter as seemingly varied as American Indian history, women in science, and the effects of nuclear war. Those kinds of plays, developed in conjunction with the museum's curatorial staff, take the role of interpretation well beyond the explication of artifacts. The presentations and the exhibits they supplement make strong social statements as well.[17]

In commenting on his service to the Task Force on Museum Education, Nicholas Brown, executive director of the National Aquarium in Baltimore, asked the rhetorical question of whether it matters that Napoleon's soldiers created the anguish on the face Goya painted. Does explanatory or background material bias the viewer?[18] The answer, of course, has little to do with the artifact or the documentation. The bias, after all, is not so much in the background materials as it is in the designer's purpose. With the Science Museum use of theater, that purpose more clearly takes center stage.

Bridal's reflection about the use of theater in museums makes the point quite clearly. Her *Journal of Museum Education* essay questions whether the use of theater could assist the museum in examining the "largely unexplored and thorny issues that technology, history, and human development raise." She asks: "Should it be a museum's mission to warn of dangers, to encourage thoughtful progress, to raise doubts—and perhaps even fears—about our future?"[19] The purpose she describes moves museums far beyond their role

as repositories of cultural artifacts, far indeed beyond any of the traditional acquisition, preservation, study, or exhibition function. The intent of the exhibits Bridal is talking about is to challenge complacency, explore contemporary issues, and reexamine beliefs.

Ludmilla Jordanova's discussion of the exhibits in the Bethnal Green Museum of Childhood in London identifies the inadequacies of traditional exhibit design that prompt the appeal of theater. The Bethnal Green collection was assembled in order to "help museum visitors to sense what it was like to be a child, or a parent, in the past." While Jordanova notes the empirical impossibility of actually knowing what it is like to be someone else, she makes a more salient point in examining the toys, games, and children's books that the Museum actually displays. "For example," she writes, "class differences and child labour are rarely mentioned, let alone vividly evoked in museums of childhood. . . . Similarly, we know that many, perhaps most children a century ago owned few toys, had little chance for 'play', received little or no education, and started work at a young age, yet in a museum of childhood we admire the fine craftsmanship of attractive Victorian toys that were for a tiny minority of children, without being conscious of dishonesty." Jordanova suggests that we don't display the painfully different reality because such a display would, in effect, force us to reexamine our illusions about history.[20]

The use of theater as an interpretive technique directly confronts the visitors' illusions about both history and contemporary life. The focus on issues of social significance in the plays of the Science Museum (the role of women in American society, for example, or the limits of medical technology) is, perhaps, a radical gesture. But the attempt to help people understand the issues that lie behind the development of technology, the telling of history, and our beliefs about human development seems singularly mainstream. "There is no basis for the fear that by raising the issues we will appear to be taking sides," Bridal writes. "There is every indication, however, that the public appreciates a responsible approach, one that presents the facts and raises questions about where those facts lead us."[21]

If, as the Task Force on Museum Education suggests, we should strengthen and expand the educational role of museums, responsible effective approaches to helping visitors learn from the collections are needed. Rather than saying good-bye to the stuffed elephants, we should pay careful attention to the tale the elephants can tell.

■

Notes

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2. Honan, "Say Goodbye to the Stuffed Elephants," *New York Times Magazine*, Jan. 14, 1990, pp. 35–38.

3. Smith, "Museums, Artefacts, and Meanings," in *The New Museology*, ed. Peter Vergo (London: Reaktion Books Ltd., 1989), pp. 6–21.

4. Honan, p. 38.

5. Susan F. Rosen and Charlotte Moser, "Primer for Seeing: The Gallery of Art Interpretation and Katharine Kuh's Crusade for Modernism in Chicago," *Art Institute of Chicago Museum Studies* 16 (1990): 6–25.

6. Linda Nochlin, "Museums and Radicals: A History of Emergencies," in *Museums in Crisis*, ed. Brian O'Doherty (New York: George Braziller, 1972), p. 36.

7. Vergo, "The Reticent Object," in *New Museology*, pp. 41–59, quotation from p. 46.

8. Ibid., p. 55.

9. Nochlin, pp. 7–41.

10. Ibid., p. 8.

11. Ibid., pp. 20–21, 36–37.

12. Task Force on Museum Education, "Excellence and Equity: Excerpts from the Report of the Task Force on Museum Education," *Journal of Museum Education* 16 (Fall 1991): 4–17.

13. Gail Anderson, "A Challenge at the Core," ibid., p. 6.

14. Robertson, "The Musuem and the Democratic Fallacy," in *Museums in Crisis*, pp. 75–89, quotation from p. 79.

15. Lee Oestreicher, "Museum Theater: Coming of Age," *Journal of Museum Education* 15 (Spring–Summer 1990): 4–5.

16. Bridal, "Center Stage in the Museum: Using Theatre to Present the Issues," *Journal of Museum Education* 14 (Winter 1989): 19–21.

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19. Bridal, p. 20.

20. Jordanova, "Objects of Knowledge: A Historical Perspective on Museums," in *New Museology*, pp. 22–40.

21. Bridal, p. 22.

Phillip V. Davis is Associate Professor of Medical Humanities and Director of the Medicine and Society Program at Southern Illinois University School of Medicine, Springfield. He is also serving an interim appointment as Deputy Chairman of the Family Practice Department. He holds a master's degree in literature from Duke University and a doctorate in education from Southern Illinois University at Carbondale. Dr. Davis is a member of the Editorial Board of the Medical Humanities Series of Southern Illinois University Press.

A Place to Stand: The Playwright's Perspective

Museum theater is, of course, theater that takes place in a museum. While this may seem obvious, it is important to distinguish the form from other kinds of public presentations. Museum theater is not a demonstration, although it may have demonstrations within it. It is not a lecture, although it may have its moments (few, we hope) of didactic explanation. It is not an informal presentation, although the actors may address the audience casually and spontaneously as docents and other explainers do. Museum theater involves actors, usually costumed, portraying characters other than themselves and performing a play with an educational thrust.

Dan Berkey portrays electrical engineer Nikola Tesla in the SMM play "War of the Currents."

(Courtesy Science Museum of Minnesota)

Theater at the Science Museum of Minnesota

Like any other kind of museum exhibition, theater presentations must transmit information clearly and accurately. The facts must be straight. Thorough research and documentation are essential. At the Science Museum of Minnesota (SMM), each developing script is assigned to a content specialist with expertise in the subject matter. The content specialist begins by working closely with the playwright, suggesting sources for research and checking each revision for accuracy in large concepts as well as specific details. Since the playwright has the Herculean challenge of taking what is often highly complex and technical information and transforming it into a lively presentation comprehensible to a lay audience, the collaboration of specialist and playwright is all-important. (I remember well the patience of the content specialist who explained the niceties of alternating current to me at

by Timothy Cope

least ten or twelve times before I was able to incorporate the theory effectively into revisions of a play about Nikola Tesla, the great electrical engineer.) Particularly when dealing with technical material, the content specialist is extremely important. Sometimes in the process of translating complex language into simpler terms, concepts or facts may inadvertently become distorted. Even juxtaposing a phrase or a word can drastically alter meaning and render the sentence inaccurate.

Once the subject matter has been thoroughly researched, the playwright distills the vast amount of material gathered and begins to transform it into a play. Succinctness is important. Visitors' attention spans must be taken into account. A play overly-saturated with facts can be didactic and uninteresting. Educational though it may be, museum theater is not a lecture; it is a play. Museum theater should continually engage the audience. The information must be kept simple because not all members of the audience have the background or inclination to follow highly technical explanations of complex subjects.

Most SMM plays are between fifteen and twenty minutes in length. Occasionally, exceedingly complex pieces may be as long as forty minutes. The briefest play in the SMM recent repertory is only ten minutes long. Ten minutes, even twenty, is not much time to communicate significant points, particularly in the context of a story that must have a beginning, a middle, and an end. Not the least of the decisions made by each play's creators is priority of information. A play with too little empirical, theoretical, or historical data runs the risk of seeming superficial (at least in a museum setting), while a play overly saturated with facts will lose the audience.

The Script Bibliography

Every SMM play is accompanied by a bibliography, even though only a fraction of the research can be used in the script. Bibliographies do more than document the factual content of a play. They are important ongoing components, referred to by actors long after the playwrights have moved on to other projects. Once the play is in performance, actors find themselves in interaction with audiences; new questions may arise, or perhaps even new material about the subject itself. It is imperative that actors have an in-depth knowledge of the subject matter. As a rule, SMM performers undertake their own research of a play's topic, initially by retracing the writer's research and reading the books and articles that the writer has read.

Also, after the play is written, who knows in what part of the brain the author will file all those interesting facts on dinosaurs or DNA or Darwin. But to the actor in performance, all that information is the everyday stock-in-trade. The writer can forget, but the performer must remember; it is possible that within a few months the actor may actually know more about a play's topic than the script's original creator.

"Sara the Scientist," performed by actors Neil Spencer and Joan Lisi at the Science Museum of Minnesota

(Courtesy Science Museum of Minnesota)

The Museum as Stage

Even though the *raison d'être* of the museum play may be to teach or instruct, the play must stand on its own as a piece of theater. If the various components of a play—plot, character, costumes, scenery, lighting, etc.—merely overlay an educational agenda, the result will not be good theater. Successful museum plays are most likely to be created by theater professionals—directors, designers, actors, and playwrights—who are proficient in their craft and have learned to work with the specific constraints that museum theater entails.

What are those constraints? They include personnel, facility, time, and—the greatest of all, of course—money. Money impacts everything else. The current SMM annual theater budget is approximately $100,000. This may seem like a large amount (and indeed it is as far as museum theater budgets go!), but the SMM program has taken more than twenty years to evolve and mature. That budget provides for the salaries of the director, five-person acting company, and support personnel.

In the early days, most SMM theater presentations were monologues—brief, single-person plays that were often researched and written by the persons performing them. Monologues make minimal financial claims upon an institution: Only one actor is needed, and only one costume (usually) must be

made. Monologues are a cost-effective first step for museums and other institutions interested in embarking upon a theater program. Indeed, the monologue is still the foundation of the SMM acting repertory. The necessity of doing things on a small scale does not mean they cannot be done well.

This brings us to the question of space. In most institutions, space is at a premium. Auditoriums (when present) are not waiting vacant for someone to produce a play. Theatrical productions do not have to occur in a theater, however.

Archimedes, the great Greek physicist, said, "Give me a place to stand and I will move the earth." He meant with a lever, of course, but the same statement applies to a playwright with an interesting story to tell. All that is needed is a place to stand. Over the years, special performance areas have been created for SMM productions, but the museum has a commitment to producing many of its plays right in the exhibit halls. In doing so, it attempts to integrate the contents of the plays with the themes of the exhibits.

The Science Museum of Minnesota

(Courtesy Science Museum of Minnesota)

Time is perhaps the single element that cannot be simplified. Plays take

1992 SMM Museum Workshop

The Science Museum of Minnesota is accepting applications for the Eighth Annual Museum Theatre Workshop, to be held on September 15–19, 1992. Past workshops have drawn participants from institutions all over the world.

The two-part workshop will provide the basic information needed to start a museum theater program, an opportunity to hear about and observe programs in other museums, and a chance to participate in the development and performance of an actual museum theater script.

More information is available from Russ Purdy, Assistant to the Director, Theatre Department, Science Museum of Minnesota, 30 East Tenth Street, St. Paul, MN 55101; (612) 221–9488.

Joan Lisi as Elizabeth Blackwell, in a 1986 production of "A Visit with Dr. Blackwell"

(Courtesy Science Museum of Minnesota)

time to write and rehearse and perform. Usually a minimum of several months' research and writing is necessary before the playwright can produce a first draft of a script. That draft is subject to a number of revisions even before rehearsals begin, and the revision process may continue throughout the rehearsal period. Rehearsals typically last several weeks, if not longer, depending on how densely they can be scheduled.

But why take the time? Does all the sound and fury that goes into creating a museum play signify anything?

It does! Although much study remains to be done, evaluations at our institution and elsewhere indicate that museum theater can encourage visitors to spend more time in an exhibit and to become more receptive to learning while at the museum.

Theater as Education

Theater helps the Science Museum of Minnesota meet a number of our educational goals. Our plays aid the public in seeing that science has an impact on everyday life.

Theater also provides a context in which to debate the social and ethical issues of science. "Sara the Scientist," for example, examines the problem of sexism in science, as do the historical monologues "Madame Curie" and "A Visit with Dr. Blackwell." These pieces demonstrate, as do our other biographical plays, that science is a social process

and that the scientists behind the invention or the theory are real people with real feelings, problems, and joys.

Theater can disseminate up-to-date, accurate scientific information. When "Space Crystals" was originally produced, the events it dramatized were barely more than a year old. Plays are periodically revised and updated if relevant, new information is discovered or new ideas come to the fore.

Finally, theater provides an atmosphere in which visitors can easily pursue informal learning. Taking notes is not the aim. Passing tests is not the aim. Who knows how many people will be able to elucidate the theory of radioactivity after watching "Madame Curie"? We hope that some will; but even if we only awaken an interest or make the subject slightly more comprehensible, then the play has succeeded. Our aim is to open the door to science. Museum theater can prop open that door and then let whoever will, go through the portal.

■

Timothy Cope is a playwright and the former Assistant to the Director of Theatre at the Science Museum of Minnesota. He is the author of educational scripts on such diverse topics as alchemy, paleontology, space technology, chemical health, folk dancing, serendipity in science, medical history, and the rise of civilization. His most recent project is a script about the rain forests, commissioned by the Philadelphia Zoo for performance in 1992. Mr. Cope lives in Minneapolis and is currently crafting short fiction and longer plays.

Museum Theater Reading List

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"Breaking the Genetic Code" focused on the research of Nobel laureate Marshall W. Nirenberg.

(Courtesy of the Stetten Museum)

Present at the Creation
The First Five Years of the Stetten Museum

A diary from 1915 and some instruments destined for the trash heap provided the inspiration for the DeWitt Stetten, Jr. Museum of Medical Research at the National Institutes of Health (NIH).

During the early 1980s, the late DeWitt Stetten, Jr., then senior scientific advisor to the NIH director, acquired what became the nucleus of the museum collection when he offered to solve a dilemma of working scientists: What should be done with classic research instruments that have been superseded by newer models? Research instruments had played a key role in medical discoveries during the twentieth century, including the development of antimalarial drugs during World War II and the techniques of open-heart surgery.

No mechanism existed at NIH for saving such artifacts, and Stetten literally salvaged one or two from the scrap heap. He arranged for a few to be exhibited in the Warren Grant Magnuson Clinical Center at NIH. He also mounted an exhibit on the brilliant epidemiological work of Joseph Goldberger, a United States Public Health Service officer, who in 1914 identified pellagra as a nutritional deficiency disease. This exhibit, which highlighted agency history, was motivated by the discovery at NIH of a diary kept by Goldberger in 1915 during a follow-up investigation of pellagra in the South.

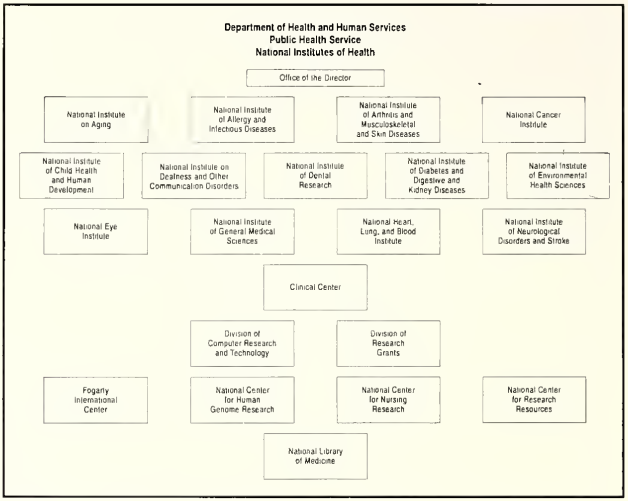
These early efforts coalesced into a proposal for establishing a museum as a part of the NIH centennial observance in 1986–1987. Stetten's long and distinguished career provided a platform from which he could argue effectively for the creation of the museum. Elected to the National Academy of Sciences for elucidating the physiology of gout, he had held numerous administrative posts at the NIH, including director of intramural research at the National Institute of Arthritis and Metabolic Diseases, director of the National Institute of General Medical Sciences, and NIH deputy director for science. In 1984 he co-edited *NIH: An Account of Research in Its Laboratories and Clinics* and was preparing the manuscript at the same time that I was completing a book on the early policy history of NIH.[1] Our book-related discussions expanded to include artifact-preservation issues as the NIH centennial approached. In October, 1986, at the beginning of the year-long observance, Stetten's quest for a museum was successful. The NIH Museum of Medical Research—renamed in Stetten's honor a few months later—was established by the NIH director, and I was named curator and NIH historian.

by Victoria A. Harden

The NIH is the principal biomedical research agency of the federal government. Its parent is the Public Health Service, a part of the Department of Health and Human Services. Comprised of twenty-two institutes, centers, and divisions (see chart), the NIH provides most of the federal funds that support biomedical research in the United States. More than 80 percent of its budget is distributed in grants and contracts to university investigators. The NIH also supports a research program in laboratories on its Bethesda, Maryland, campus.

The Stetten Museum is located administratively within the Office of the Director, NIH, under the Associate Director for Communications, a position chosen in order to serve all the institutes, centers, and divisions of the agency. A group of NIH scientists, administrators, and other staff serves as an advisory committee to the museum. For a novice curator seeking to respond to some four thousand scientists and more than fifteen thousand total staff, the advisory committee has proved invaluable. It recommended, for example, that the museum seize the opportunity offered by the 1987 NIH centennial observance to bring the historic contributions of the agency to public and staff attention.

Although time was extremely short for preparing exhibits, the Stetten collaborated with six of the oldest NIH institutes to highlight one research program of each in a series titled, "Windows into NIH History: A Centennial Retrospective." Preparing those exhibits not only stimulated the participating institutes to think about their artifactual heritage but also prompted NIH investigators to channel instruments and other artifacts to the Stetten collection. The exhibits and their sponsors were: "The Fluoride Story: How Dental Research Put a Secret of Nature to Work" by the National Institute of Dental Research; "Rocky Mountain Spotted Fever" by the National Institute of Allergy and Infectious Diseases; "Cell Culture: Foundations of Cellular and Molecular Biology" by the National Cancer Institute; "The Heart-Lung Machine: Advances in Heart Surgery Techniques," National Heart, Lung, and Blood Institute; and "Windows into the Brain" by the National Institute of Mental Health and the National Institute of Neurological Disorders and Stroke.


Department of Health and Human Services
Public Health Service
National Institutes of Health
Office of the Director
National Institute on Aging
National Institute of Allergy and Infectious Diseases
National Institute of Arthritis and Musculoskeletal and Skin Diseases
National Cancer Institute
National Institute of Child Health and Human Development
National Institute on Deafness and Other Communication Disorders
National Institute of Dental Research
National Institute of Diabetes and Digestive and Kidney Diseases
National Institute of Environmental Health Sciences
National Eye Institute
National Institute of General Medical Sciences
National Heart, Lung, and Blood Institute
National Institute of Neurological Disorders and Stroke
Clinical Center
Division of Computer Research and Technology
Division of Research Grants
Fogarty International Center
National Center for Human Genome Research
National Center for Nursing Research
National Center for Research Resources
National Library of Medicine

***A 1991 organizational chart of the National Institutes of Health, from the* NIH Data Book, 1991**

(Courtesy of the Stetten Museum)

In 1989 those exhibits were awarded the John Wesley Powell Prize of the Society for History in the Federal Government.

With the inaugural series of exhibits completed, the tasks of establishing museum policies and procedures were addressed. In 1988 and 1989 the advisory committee defined a mission statement and collections policy. The mission of the Stetten Museum is to collect and exhibit twentieth-century biomedical research instruments and other artifacts relating to the history of the National Institutes of Health. Because of this narrow focus, we have redirected most offers of clinical instruments to other museums. Exceptions have been made only when a direct relationship to the agency has been demonstrated, such as clinical instruments developed by NIH investigators.

Another major challenge has been inventorying and cataloging the original collection while continuing to accession instruments and to design new exhibits. With the assistance of a contractor, a cataloging system compatible with that of the Smithsonian Institution museums has been instituted; eventually, much of the information will be put into an electronic data base. An optical disk imaging system will facilitate management of the considerable paper documentation received with some instruments, including scientific notebooks, reprints of papers about the instruments, and the like.

Cataloging biomedical research instruments, we have discovered, poses particular problems because they are often so specialized that expert consultation is required, especially when the objects are unique and will not be found in catalogs of commercially produced instruments. To assist us, we have developed a pre-accession form on which potential donors describe the instrument and its importance, list related scientific references, and provide other cataloging information. Cooperation has been most gratifying from NIH scientist-donors, who are also primarily responsible for growth in the collection. With a few exceptions, the staff has not actively sought to acquire objects. Storage space for the collection has been outgrown twice since 1987, and the collection is unlikely to shrink. To help alleviate the situation, we hope to acquire space in a large warehouse for storage.

The Van Slyke manometric apparatus, introduced in 1921, permitted physicians to monitor chemical changes in patients' blood and other fluids. Shown with the Van Slyke exhibit in 1991 are, from left, Reginald Archibald, M.D., and Rollin Hotchkiss, Ph.D., of the Rockefeller University, who presented a seminar on the clinical and basic research applications of the instrument.

(Courtesy of the Stetten Museum)

Beginning with the centennial series, exhibits have been prepared with non-technically trained, general audiences in mind. Since many of the pieces in the Stetten collection are arcane rather than familiar and intimidating rather than engaging, our challenge has been to set them in context, explaining their function while interpreting their use in research projects more familiar to the public. When, for example, Marshall W. Nirenberg, an NIH Nobel laureate, offered the museum instruments used during his prizewinning research on the genetic code, we accessioned a French press, a DuPont-Sorvall centrifuge, a Cary 15 spectrophotometer, a Miles Hivolt, Ltd. electrophoresis instrument, and a multiple Millipore filter device designed and constructed at NIH specifically for his research. Our "Breaking the Genetic Code" exhibit commemorated Nirenberg's work in elucidating the fundamental mechanism of how DNA in cells directs the synthesis of proteins in all living things. Opened in September of 1988 and still a popular exhibit, it employs schematic diagrams as well as text to explain each instrument and its role in Nirenberg's discovery.

Because the Stetten Museum is a "museum without walls," we must also design exhibits to fit the minimal space available in public areas at NIH. For the 1990 "Computers in Medical Research" exhibit, we had a space of only twenty-eight feet along one wall, with a depth of no more than three feet. Our ambitions, however, exceeded these limits. We wished to discuss the use of computers in basic laboratory research, in the clinical research setting, and in biomedical communications. Working with the three NIH components representing these three applications, we identified instruments that would fit the available space and turned to a menu-driven video disc to provide additional information and to show larger instruments. The touch-screen video disc, prepared by the National Library of Medicine, is being modified to add closed captions for hearing-impaired viewers in response to their requests and in accordance with the Americans with Disabilities Act.

The Stetten Museum continues to cooperate on many exhibits with other NIH components and organizations. In November, 1991, the museum observed the fiftieth anniversary of the establishment of the NIH campus in Bethesda, Maryland, in conjunction with the NIH Alumni Association. With the assistance of a committee of alumni who had worked at NIH in 1941, we prepared "Seventy Acres of Science: Establishing the NIH Campus at Bethesda, 1930-1941." In joint sponsorship with the Alumni Association, we also offered a historical symposium on the subject.

A new exhibit, still in the planning stage, will feature a Cray supercomputer used by the National Cancer Institute (NCI), the first supercomputer devoted specifically to biomedical research. NCI donated the instrument to the Stetten and is providing major financial support for the project.

In addition to exhibits, the Stetten Museum promotes historical research and writing about twentieth-century biomedical research and technology. In

Brooks Photographers

DeWitt Stetten, Jr.

(Courtesy of the Stetten Museum)

The "Computers in Medical Research" exhibit is situated along a major thoroughfare in the NIH Clinical Center.

(Courtesy of the Stetten Museum)

1989 it cosponsored the international "AIDS and the Historian" conference, which brought together scholars from across the United States and Europe to discuss the history of this disease and how it might be documented and studied.[2]

Most recently, the Stetten Memorial Fellowship has been established by the Foundation for Advanced Education in the Sciences, Inc., a non-federal, nonprofit organization that supports museum activities. The fellowship, which will begin in 1993, will fund a year's residence at the Stetten for a pre- or post-doctoral student in the history of twentieth-century biomedical sciences or technology. Applications are now being accepted.

In 1990, recognizing our fifth anniversary, the Stetten Museum advisory committee undertook a five-year plan to guide the institution toward its tenth anniversary. Since financial, space, and personnel resources are unlikely to keep pace with opportunities, creative approaches were sought to extend the museum's work. Although the staff has grown to four, additional personnel are needed for specialized tasks. The museum hopes to draw on the expertise of retired NIH staff, establishing joint ventures with a recently created history committee of the NIH Alumni Association. To improve collecting efforts and exhibit coverage for all NIH components, we will propose creation of an NIH history-museum committee, which will meet regularly and be composed of representatives from each NIH component.

Our collections policy will be slightly revised to encompass biomedical research technologies as well as instruments. The staff continues to discuss how best to implement this change, because the tools of current research, such as molecular biology, are often disposable. Collecting in this area may involve acquiring samples of types of equipment, not actual equipment used in a particular research project. It

will permit, however, the documentation of research during the last decades of the twentieth century.

Having been present at the creation of a new museum, I can look back with some pride that DeWitt Stetten's vision of making the process of biomedical research accessible to the public has begun to be realized. Liaison with other museums, membership in professional associations, and generous advice and assistance from individuals have made the tasks of establishing a professional foundation much easier.

At our tenth anniversary in 1996, we will be looking toward the new century, when the Stetten Museum must consider updating its mission statement to include twenty-first century biomedical research technologies. In the meantime, we hope to continue collecting the artifacts of biomedical research and preparing exhibits and publications to highlight this vital activity of the United States government.

Notes

1. DeWitt Stetten, Jr., ed., and W. T. Carrigan, assoc. ed., *NIH: An Account of Research in Its Laboratories and Clinics* (Orlando: Academic Press, 1984); Victoria A. Harden, *Inventing the NIH: Federal Biomedical Research Policy, 1887–1937* (Baltimore: Johns Hopkins University Press, 1986).

2. Victoria A. Harden and Guenter B. Risse, eds., *AIDS and the Historian: Proceedings of a Conference at the National Institutes of Health, 20–21 March 1989*, NIH Publication No. 91-1584 (Bethesda, MD: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, 1991).

An avid woodworker in his spare time, DeWitt Stetten, Jr., founder of the Museum, appreciated the craftsmanship required to produce precision scientific instruments. Among the artifacts he personally donated to the museum was this Curta mechanical calculating device, machined in Liechtenstein about 1945.

(Courtesy of the Stetten Museum)

DeWitt Stetten, Jr. Museum of Medical Research

Director: Victoria A. Harden

Address: National Institutes of Health
9000 Rockville Pike
Bethesda, MD 20892

Museum exhibits are located in Buildings 1, 10, and 31 (the James A. Shannon Building, the Warren Grant Magnuson Clinical Center, and the Claude D. Pepper Building, respectively). On-campus visitor parking is extremely limited on weekdays. Best access is by subway, exiting at the Medical Center stop on the red line. A free NIH campus shuttle runs every fifteen minutes from the subway and stops at each building in which exhibits are located.

Telephone: (301) 496–6610

Hours: Monday through Friday, 8:30 A.M. – 5:30 P.M. Exhibits in the Clinical Center are also open on weekends and are lighted from 8:30 A.M. – 6:30 P.M.

Admission: Free

The collections are available for research by appointment. Inter-museum loans are also possible. Prior arrangements should be made with Victoria A. Harden.

Victoria A. Harden took her B.A. in history from Emory University in 1966 and her M.A. in American history from the University of Florida in 1968. After teaching for ten years, she returned to Emory for a Ph.D. in American history, graduating in 1983. She held a predoctoral fellowship at the National Museum of American History, Smithsonian Institution, and she spent a postdoctoral year at the Institute for the History of Medicine, Johns Hopkins University School of Medicine, under the auspices of a grant from the National Library of Medicine. She is the author of Inventing the NIH: Federal Biomedical Research Policy, 1887–1937 *(Johns Hopkins University Press, 1986) and* Rocky Mountain Spotted Fever: History of a Twentieth-Century Disease *(Johns Hopkins University Press, 1990), which won the Henry Adams Prize of the Society for History in the Federal Government. She teaches a course in the history of medicine in the evening graduate school at NIH and is currently working on two projects, the history of the NIH response to AIDS and the history of the Aminco-Bowman spectrophotofluorometer.*

Medical Biographies Exhibit at The Pearson Museum

In observation of Black History Month at Southern Illinois University School of Medicine, The Pearson Museum hosted "The Afro-American Presence in Medicine, 1850–1930," an exhibit compiled by Doris Y. Wilkinson, Professor of Sociology at the University of Kentucky.

The award-winning author of several books and articles on contemporary and historical perspectives on African-Americans, Dr. Wilkinson designed the exhibit to focus on experiences of twenty-four black physicians who attended predominantly white medical schools. "The Afro-American Presence in Medicine" is the first comprehensive treatment of these graduates, and will soon be expanded to a book-length manuscript.

Wilkinson, herself, was one of the first to break the color barrier at the University of Kentucky shortly after the 1954 United States Supreme Court decision outlawing segregation in public schools. Majoring in social work with a minor in English, she began graduate work at Case Western Reserve University in Cleveland. After earning a doctorate at Case and a master of public health degree at Johns Hopkins University, she returned to the University of Kentucky, becoming the first African-American woman to join the full-time faculty.

In 1988 she received the Du Bois-Johnson-Frazier Award of the American Sociological Association for excellence in research, teaching, and professional and community achievements. In her honor, the University of Kentucky established the Doris Y. Wilkinson Leadership Award for students who display outstanding scholastic and leadership abilities.

In explanation of her achievements, Dr. Wilkinson says simply: "I like my work. I have never wanted to do anything else but teach, which is my joy, and writing is my hobby. I am very blessed to be able to do those things which I consider most interesting."

"The Afro-American Presence in Medicine, 1850–1930" is comprised of twenty-four portraits and biographical sketches, beginning with Dr. Martin Delaney, who started practicing in 1852 and was the first black commissioned officer in the Civil War. The exhibit chronicles the careers of four female physicians, including Dr. Susan Steward of New York, who graduated in 1870.

All of the featured physicians share a common theme of persevering against great odds. Many went on to make important contributions in research or practice. Among the most celebrated in the group is Dr. Daniel Hale Williams, who pioneered open-heart surgery in Chicago. The biographical statements

Doris Y. Wilkinson

by Barbara Mason

accompanying the exhibit highlight personal convictions as well as medical achievements. Dr. Charles Drew, who served as Director of the American Red Cross Blood Bank, eventually resigned that office in protest over the Red Cross policy of accepting only white donors for transfusions needed during World War II. Ironically, Drew's death occurred as a result of injuries from a traffic accident, from which a blood transfusion would have saved him. None was available.

Another, less well-known practitioner identified in "The Afro-American Presence in Medicine" is Dr. Henry Weathers of East St. Louis, Illinois, who may well have been the first surgeon to repair the heart. In the early 1930s, Weathers was called to attend a patient with a stab wound to the ventricle. He successfully closed the wound, and the victim recovered.

"The Afro-American Presence in Medicine," along with additional profiles of eminent local African-American physicians, provided the perfect backdrop to a one-day symposium sponsored by the Southern Illinois University School of Medicine chapter of the Student National Medical Association. The keynote speaker was Alma Rose George, M.D., President of the National Medical Association, who spoke on "The Future of Health Care in Minority Communities." George is president of the medical staff at Mercy Hospital in Detroit. She received her degree at Meharry Medical College in 1960 and completed advanced training in surgery at Detroit General Hospital. She has focused much of her professional life on indigent care, training programs for minority physicians, quality assurance, and risk management.

Panels from "The Afro-American Presence in Medicine, 1850–1930" can be seen in this photograph of Dr. Alma Rose George, President of the National Medical Association, and SIU student chapter President Dwane Broussard.

"The Afro-American Presence in Medicine" was previously on loan to The Harvard Medical School. Requests for 1993 scheduling may be directed to Professor Wilkinson at the Department of Sociology, 1561 Patterson Office Tower, University of Kentucky, Lexington, KY 40506–0027.

■

Barbara Mason is Curator of The Pearson Museum and coauthor of two volumes in The Pearson Museum monograph series.

Editorial

When we launched *Caduceus* in 1985, scholars were just beginning to become aware of the phenomenal growth of museums since the exuberant celebrations and subsequent national pride engendered by the Bicentennial of the Republic. Medical, pharmaceutical, and technology museums more than doubled between 1976 and 1986. Established centers for material culture now include exhibits on aspects of health and illness. There are specialty organizations for the history and anthropology of each of the major health science professions, and specialty organizations for museums, including the Medical Museums Association.

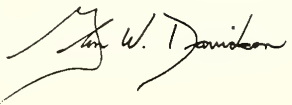
With specialization have come standards, better distinctions for making interpretations, and codes of ethical and legal practice. As with the gigantic American Association of Museums (AAM), members of the small Medical Museums Association are beginning to articulate criteria by which to assess the role of specialty institutions and to be measured by accrediting bodies. Perhaps the single greatest issue is what the ethics for such museums should be.

Historians have given greater attention to the changes that have occurred in medicine. Perhaps the single greatest change of the last twenty-five years, as with museums, relates to the ethics of health care. Ethics, either theoretical or clinical, has become such a sophisticated area of inquiry, that it too requires specialists. How are curators of the continent's health science museums to tell the stories of medical ethics? Several essays in this issue present both theoretical issues and practical suggestions about how to convey the stories to museum audiences.

Conveying stories and interpretations has been our mission since 1985, and that mission received a most satisfying recognition recently from the AAM. *Caduceus* was among five scholarly journals to be given an Award of Merit this April in the annual AAM publications competition. Other honorees included the Art Institute of Chicago, the St. Louis Art Museum, the Denver Art Museum, the Philadelphia Art Museum, and the International Museum of Photography.

Our award-winning issue was Spring of 1991, on "Museums and the Human Remains Controversy." Contributors wrote on ethical controversies surrounding human remains, including the responsibilities of museums.

The AAM award is not only a pleasant recognition of our efforts but also an important indication of the powerful stories that can be shared by those of us who toil in the health sciences. It also provides me with an opportunity to thank those of you who have supported *Caduceus* over the years with scholarship, expert reviewing, and subscriptions.



Announcements

The Mütter Museum

The unexpected art inherent in the study of medical science is captured in *The Müter Museum 1993 Calendar,* available in September from the Mütter Museum of the College of Physicians of Philadelphia. The calendar, comprised of thirteen black-and-white duotones, is the work of six fine-art photographers, who selected their subjects from the twenty thousand artifacts in the Mütter collection. Medical information accompanies each photograph. The calendar is spiral bound, measuring 11 3/4" by 11"; it sells for $14.95, plus $1.50 postage. Orders may be placed through Linda Lindgren, Calendar Coordinator, P.O. Box 51, Cooper Station, New York, NY 10276-0051, or (212) 674-6367.

The Strong Museum

"Altered States: Alcohol and Other Drugs in America," an exhibition of the Strong Museum of Rochester, New York, will open on October 24, 1992.

The most ambitious exhibit to date by an American history museum on the subject of chemical use and abuse, "Altered States" begins in the 1600s, when Europeans were introduced to tobacco. Visitors will journey through the hard-drinking frontier days, the temperance movement, prohibition, the psychedelic sixties, to the present.

The exhibit includes photographs, film clips, posters, hundreds of drug-related objects, a community forum, a two-day symposium, and a resource center where visitors can find current literature and treatment information. Patricia Tice, curator and principal researcher for the exhibit, gathered drug-related objects from forty-four institutions and private collectors across the country.

Among the more unusual items are a cirrhotic liver specimen and an 1890s wax model of a heroin addict's arm (both loaned by the National Museum of Medicine and Health in Bethesda, Maryland), a door from a crack house (loaned by the Rochester, New York, Police Department), and a hypodermic kit manufactured for home use in 1885 by Parke Davis (loaned by the Smithsonian Institution National Museum of American History).

"Altered States" is not intended as a didactic treatise on the dangers of drugs; rather, it presents the facts and allows the viewer to form his or her own conclusion. "Our mission as a museum is to shed light on a subject that is a real, measurable, and terrifying problem in 1992," says Scott Eberle, chief historian. The exhibit goes beyond the pharmacological properties of drugs. It intertwines their historic, physiological, social, and political dimensions.

As a complement to the exhibit, the Strong Museum will host a scholarly symposium on November 13-14, 1992. Invited speakers include scholars from a variety of disciplines relating to health, education, history, and the museum

profession. Sessions focus on shifting social attitudes, medical approaches, legal policies concerning drugs and alcohol, and curatorial issues for museum professionals. Strong Museum staff will give practical advise on handling exhibits concerning controversial social issues. Registration is required.

The "Altered States" exhibition and symposium are funded primarily by a $280,000 grant from the Robert Wood Johnson Foundation, with additional support from the B. Thomas Golisano Foundation. The Strong Museum, in cooperation with the Smithsonian Institution Traveling Exhibition Service (SITES), plans to produce a traveling version of the exhibit for showing in several major metropolitan areas.

For additional information about the "Altered States" exhibit and symposium, write the Public Information Office of the Strong Museum, One Manhattan Square, Rochester, NY 14607 or call (716) 263-2700.

The Pearson Museum

The Pearson Museum of Southern Illinois University School of Medicine, Springfield, announces the latest volume in The Pearson Museum Monograph Series: *The Emmet F. Pearson Collection of Disinfected Mail,* by Glen W. Davidson, Lisa Dziabis Calache, Mary Ellen McElligott, Debra Kuhn McGregor, and Barbara Mason.

The seventy-page book is a guide to the 206 manuscripts in the Emmet F. Pearson Collection of Disinfected Mail, all of which were subjected to disinfection procedures between 1655 and 1918. The volume contains an introductory essay by Glen W. Davidson, a chronology of recorded postal disinfection in the United States, and a transcription of a nineteenth-century diary of a traveller quarantined in a Genoa lazaretto.

The book is available from the publisher for $15, plus $3.00 handling and postage. Orders are accepted at The Pearson Museum, Department of Medical Humanities, SIU School of Medicine, Box 19230, Springfield, IL 62794-9230, or (217) 782-4261.

Cleveland Health Education Museum

"Brain Trek: It'll Blow Your Mind," the summer-long program sponsored by the Cleveland Health Education Museum, provides visitors with an in-depth look at the workings of the human brain.

The program features the touring exhibition "Within the Human Brain," which includes brain imaging technology and interactive computer graphics, sponsored by the Lawrence Hall of Science at the University of California at Berkeley. Special weekday programs for children will be presented through August 14; weekend programs through August 31 will feature the Ground Zero Mime/Movement Theater Company Shows.

The Cleveland Health Education Museum is located at 8911 Euclid Avenue, Cleveland, Ohio 44106-9985. For more information, write the Office of Public Affairs at that address, or call (216) 231-5010.

The Medical Museums Association

The following resolution on behalf of the Academy of Medicine of Toronto was passed unanimously by the members of the Medical Museums Association at the Annual Meeting, held at Seattle, on April 30, 1992:

RESOLUTION

Whereas, the Academy of Medicine of Toronto has been a responsible caretaker and guardian of medical history and ethics since 1907;

Whereas, the primary expression of that mandate has been the stewardship and administration of the Museum of the History of Medicine;

Whereas, the programs and collections of the Museum provide unique educational and historical services to the people of North America;

Whereas, the Museum collection of more than 12,000 pieces is an invaluable and tangible reminder of not only Canada's past but the development of eastern and western civilization;

Whereas, curators of the Museum have maintained the trust of generations of medical pioneers and their families;

Whereas, the members of the Medical Museums Association are committed to preserving and interpreting the history of medicine through professionally administered institutions;

BE IT RESOLVED that the Medical Museums Association, meeting on April 30, 1992, at the Annual Meeting of the American Association for the History of Medicine, calls upon the Toronto Academy of Medicine to pursue all options necessary to maintain the safety of the Library and Museum collections, honor all obligations to donors, abide by established ethics for holding material culture collections, and follow recognized museology practices. The Academy can thus maintain the integrity of the Museum of Medical History as a resource for the citizens of Toronto and the international community of medical and health sciences historians.

Credits

Frontispiece: *Trials of War Criminals Before the Nuremberg Military Tribunals: Volumes I and II, The Medical Case* (Washington, DC: U.S. Government Printing Office, 1948).

Pages 1, 15: *The Totally Implantable Artificial Heart,* DHEW Publication No. 74-191 (Washington, DC: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, 1973), cover and p. 33.

Page 5: Reprinted with permission from *The Atlanta Constitution* and *The Atlanta Journal.*

Page 11: M. G. Purmann, *Der rechte und warhafftige Feldscher* (Franckfurt: M. Rohrlach, 1690).

Page 12: George W. Crile, *Hemorrhage and Transfusion* (New York: D. Appleton and Company, 1909), p. 292.

Pages 24, 25, 26: Eric Y. Exit, The Goodman Theatre, Chicago, courtesy Cindy Bandle.

Page 30: Field Museum of Natural History, Chicago, courtesy Erin O'Donnell.

Pages 36, 39, 41, 42, 43: Science Museum of Minnesota, St. Paul, MN.

Pages 46, 48, 49, 50, 51, 52: DeWitt Stetten, Jr. Museum of Medical Research, National Institutes of Health, Bethesda, MD.

Page 48: *NIH Data Book, 1991,* NIH Publication No. 91-1261 (Washington, DC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, 1991), p. ii.

Page 50: Brooks Photographers, Washington, DC.

■

Cover illustration: Poster announcing "Breaking the Genetic Code," the DeWitt Stetten, Jr. Museum of Medical Research exhibit honoring Marshall W. Nirenberg, scientist from the National Heart, Lung, and Blood Institute. The background image is the actual handwritten data chart upon which Dr. Nirenberg recorded the results of his experiments. Poster design is by the Medical Arts and Photography Branch, National Center for Research Resources, National Institutes of Health, provided courtesy of the NIH Historical Office.

■

Caduceus is produced for the Department of Medical Humanities, Southern Illinois University School of Medicine, by the Division of Biomedical Communications, Illustration.

Don Biggerstaff, *Director of Biomedical Communications*

Linda Clark Ragel, *Designer*
Patricia A. Baker, *Typesetter*